ENVIRONMENTAL IMPACT STATEMENT

final

ENVIRONMENT

KAIPAROWITS

ENERGY

United States
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CHAPTER VIII

KAIPAROWITS

ENVIRONMENTAL IMPACT STATEMENT

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ALTERNATIVES TO THE PROPOSED ACTION

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SUMMARY

Technical Alternatives

Generating plant designs

Changes in location of various components might occur during final design engineering. These changes would not increase the area required for each component, and would create the same impacts to the environment as described in Chapter III.

Alternate stack marking would include 24-hour strobe lights, which would increase visual impact during night hours.

Four alternative particulate removal systems and seven alternative sulfur dioxide (SO_2) removal systems were evaluated for the participants by Bechtel Power Corporation. All of these alternatives would result in virtually the same impacts to the environment as the primary proposal.

The participants considered the following for waste disposal: the southwest corner of the proposed plant site as an alternate location for bench-top landfill, an alternative bench-top disposal method, canyon landfill, and disposal in the mine. The alternate bench-top site would require an additional 4,000 cubic yards of excavation and increase the surface disturbance by 2.3 percent (10 acres). The alternative method of bench-top landfill would involve spreading wastes behind a berm; this would result in increased erosion and visual impact. Considerable construction and excavation would be required for a canyon landfill. Necessary diversion of the natural drainage would disturb more acres of vegetation and possibly eliminate wildlife in the canyon. Approximately 2 miles by 1/2 mile of the canyon floor would be buried. Waste could also be injected into mined-out areas as a slurry; this would require 675 acre-feet annually of additional water,

and could ultimately contaminate adjacent ground water. Sufficient space in the mine would not be available for at least 10 years; however, this method may reduce subsidence.

The participants considered alternate sites, alternative designs, and alternate pipe line routes for the water supply system. One alternate site would be at Romana Mesa. This site would require an additional 10 miles of pipe line, and disturbance of 27 more acres as compared with the proposed location. It would also have an adverse visual impact. Another alternate site at Warm Creek is within 1 mile of the proposed site, and would involve the same kinds of impacts as the proposed action. Alternative designs of water intakes include a trench intake, which would cause disturbance from underwater blasting and excavation, and a jack-up offshore platform, which would involve technical problems, create a navigation hazard to boaters, and have an adverse visual impact to the lake aesthetics. An alternate pipe line route would cross Smoky Mountain; it would be longer than the proposed route and would result in more disturbance. A route up Nipple Creek, along the proposed highway, would involve less total disturbance.

Alternate locations for the reservoir and various pond lining materials were also considered. These alternatives would have the same impacts to the environment as the primary reservoir proposals.

Alternate cooling systems include cooling ponds, spray ponds, wet-dry cooling towers, and dry cooling towers. Cooling ponds would eliminate the environmental effects of drift and save 20 megawatts (MW) of power, but they would require lining, use an additional 16,000 acres of land, and increase water consumption by 16,500 acre-feet annually. Spray ponds would require less land than cooling ponds, but they would require 95 acres more than cooling towers. Spray ponds may also cause fogging and icing downwind, and would use as much energy as the proposed method. Wet-dry cooling towers require 20 to 30 percent more energy to operate.

They would have less drift loss and would use less water; however, they are relatively unproven. Dry cooling towers would not use water and, therefore, would not cause the environmental disturbance associated with the proposed wet cooling towers. Experience with these systems is limited, and research on technical feasibility is now being carried on. Possible effects on weather conditions due to release of heated air are unknown.

Six alternative limestone processing and handling methods were examined. These systems include processing at the plant, at plant and mine, at the quarry, the use of lime or limestone, and purchase from an outside supplier. Processing at the quarry site would result in an additional surface disturbance of 22 acres. Processing at the quarry would also require coal and an additional transmission line. Purchasing from an outside supplier would involve no surface disturbance in the impact area of the proposed Kaiparowits project, but would require long-distance haulage. If raw limestone were used instead of lime, a kiln and the coal used to heat the limestone would not be needed.

Coal mine design

The alternative surface mining methods of conventional area strip, multiple-bench and open-pit were examined. The amount of overburden above the coal zones, 400 to 500 feet, precludes the conventional area strip method under current technology. Multiple-bench open-pit was determined to be the only alternative.

In order to furnish the required 420 million tons of raw coal over the 35-year life of the project, an area of about 12 square miles would have to be excavated down to the coal beds. Resultant obliteration of existing vegetation, relocation and exposure of overburden, and destruction of ground water aquifers and surface water courses would cause heavy impacts on the environment. However, coal recovery would be 90 percent or more, compared to about 50 percent by underground methods, thereby conserving a nonrenewable natural resource.

The in situ mining or in situ gasification of coal were considered. This method causes greater environmental impacts than either surface or underground mining. And, at present it is not technically feasible.

Alternate transportation methods of railroad, off-highway trucks and slurry pipe line were analyzed; all indicated more adverse impacts than the proposed belt conveyor system.

Two alternative 138 kilovolt (kV) power line routes to supply power to the coal mine operations were examined. One alternative would follow much the same route as the proposed line described in Chapter I, but it would follow the general alignment of the new highway in the bottom of Wesses Canyon. The impacts for this alternative would be the same as the proposed route except along the new highway, where it would create a visual impact for highway users.

The second alternative would require construction of a new substation near Glen Canyon City. It would follow the general alignment of the new highway to the coal mine. This alternative would require 1 mile less of power line and 15 more acres of disturbance. It would also pass through a portion of the proposed new town, creating a visual impact.

Transmission system

Routes

A variety of alternate routes were considered for each of the four proposed segments of the transmission system. Fifteen alternates were considered for the proposed Kaiparowits to Eldorado route, six for the proposed Kaiparowits to Phoenix route, eight for the proposed Kaiparowits to Moenkopi to Mohave route, and seven for the proposed Mohave to Serrano route. Figures VIII-1 through VIII-4 compare the impacts resulting from each alternate route to the impacts resulting from the corresponding proposed route. For a summary of any alternate route, the reader should refer to the proper figure.

FIGURE VIII-1

Impact Evaluation of Alternate Routes for Proposed Kaiparowits to Eldorado Route[a]

		Importance to decision making[b]	Fivemile Valley	Cottonwood-Paria	East Clark Bench	Flat Top	Mokiah Wash	Black Rock Gulch	Navajo-McCullough	Highway 91	Telephone	Blake's Lambing Ground	California Wash	Lava Butte	Railroad Pass	Black Hills	Kaiparowits to Mohave
Mileage (more or less than proposed route)		5	+1	+1	+1	+9	-7	-2	-2	+2	+7	-4	-7	0	0	-1	+22
Climate		0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
Air Quality		1	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
Geology and Topography	General	1	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
	Seismology	0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
	Economic geology	0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
Soils	Erosion hazard	5	MM	MM	MH	MS	MM	MM	SS	SM	MH	MM	SS	NN	NN	NN	MH
	Rehabilitation potential[c]	5	SS	SS	MS	SM	MM	MM	MM	MS	MM	MM	SS	SS	SS	SS	MS
Water Resources	Quality	5	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
	Demand	7	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	4	SS	SS	SS	SS	SM	SM	NN	SM	SM	SS	NN	NN	NN	NN	MH
	Acres disturbed (permanent)	6	MM	MS	MM	MM	MH	MH	MS	SM	SM	MM	MM	SS	SS	SS	MH
	Acres disturbed (temporary)	6	MM	MS	MM	MM	MH	MH	MS	SM	SM	MM	MM	SS	SS	SS	MH
Wildlife	Terrestrial	9	MM	SS	MH	MS	MH	MH	HS	HS	HS	HS	HH	SS	HS	HS	MH
	Aquatic	2	NN	NN	NN	NN	SS	SS	NN	NN	NN	SS	MM	NN	SS	SS	SS
Ecological Interrelationships	Terrestrial	9	MM	SS	MH	MS	MH	MH	HS	HS	HS	HS	HH	SS	HS	HS	MH
	Aquatic	2	NN	NN	NN	NN	SS	SS	NN	NN	NN	SS	MM	NN	SS	SS	SS
Paleontology		2	SS	SS	SS	SS	SS	SS	NN	SS	SS	NN	SS	SS	SS	SS	SS
Archaeology		8	MM	MM	MM	MM	MH	MH	NN	SS	SM	NN	SM	MM	SS	SS	SM
History		6	SS	SS	SS	SS	MH	MH	NN	SS	SM	NN	SS	SS	SS	SS	SS
Recreation	General	6	MM	MM	SS	MM	MH	MH	SS	SS	SS	MM	SS	MM	SS	SS	MM
	Scenic values	10	MH	MH	HM	MS	MH	MH	MM	MM	MS	HH	MH	SM	SM	SS	SH
	Natural values	9	MM	MM	MM	MM	MH	MH	MM	MM	SS	MM	MM	SM	SM	SS	SH
Land Uses	Miles of new corridor (more or less than prop.)	9	-5	-6	0	+9	+78	+86	-12	+9	+39	0	+28	+3	+12	+7	+137
	Wood Products	1	SS	NN	SS	SS	SM	SM	NN	NN	NN	NN	NN	NN	NN	NN	NN
	Agriculture	1	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
Socio-Economic	Housing and services	1	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MH	MH	MH
	Culture and attitudes	1	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS

[a]Impacts rates as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The Second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

[c]This rating is not a comparison of impacts, but instead it is a comparison of rehabilitation potentials.

FIGURE VIII-2

Impact Evaluation of Alternate Routes for Proposed Kaiparowits to Phoenix Route[a]

		Importance to decision making[b]	John Henry	Cedar Ridge	Agua Fria	Pinnacle Peak	Antelope-Hualapai	Antelope-Wickenburg
Mileage (more or less than proposed route)		5	+3	+2	-3	+2	+36	+36
Climate		0		NN	NN	NN	NN	NN
Air Quality		1		SS	SS	SS	SS	SS
Geology and Topography	General	1		SS	SS	SS	SS	SS
	Seismology	1		NN	NN	NN	NN	NN
	Economic geology	2		NN	NN	NN	NN	NN
Soils	Erosion hazard	5		MM	MM	MM	MM	MM
	Rehabilitation potential[c]	5		MM	MM	MH	MM	MS
Water Resources	Quality	1		SS	SS	SS	SS	SS
	Demand	1		SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	4		SM	MM	MM	MM	MM
	Acres disturbed (permanent)	5		SS	SS	SH	SM	SS
	Acres disturbed (temporary)	6		SM	SS	SH	SM	SM
Wildlife	Terrestrial	8		SS	HM	MH	MH	MH
	Aquatic	4		SS	HM	SM	SS	SS
Ecological Interrelationships	Terrestrial	8		SS	HM	MH	MH	MH
	Aquatic	4		NN	HM	SM	SS	SS
Paleontology		3		SS	SS	SS	SS	SS
Archaeology		8	Same As Proposed Route	SM	MM	MM	SM	SM
History		5		SS	SM	SM	SM	SM
Recreation	General	8		MM	MH	MH	MH	MM
	Scenic values	10		MH	MH	MH	MH	MM
	Natural values	8		MH	MH	MH	MH	MH
Land Uses	Miles of new corridor (more or less than prop.)	10		+56	+45	+24	+145	+264
	Wood Products	3		SS	SS	MH	SS	SS
	Agriculture	1		NN	NN	NN	NN	NN
Socio-Economic	Housing and services	1		MM	MM	MM	MM	MM
	Culture and attitudes	5		MH	MM	MH	MH	MH

[a]Impacts rated as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

[c]This rating is not a comparison of impacts, but instead is a comparison of rehabilitation potentials.

FIGURE VIII-3

Impact Evaluation of Alternate Routes for Proposed Kaiparowits to Moenkopi to Mohave Route[a]

		Importance to decision making[b]	John Henry Alternate	Cedar Ridge Alternate	Detrital Valley Alternate	Eldorado Valley Alternate	Coal Slurry Alternate	Antelope-Reservation Aubrey Alternate	Antelope-Lake Mead-Detrital Alternate	Antelope-Lake Mead-Hualapai Alternate
Mileage (more or less than proposed route)		5	+3	+ 2	+20	+56	-5	-28	-58	-49
Climate		1	Same as John Henry Alternate of the Kaiparowits-Phoenix Route	N-N	N-N	N-N	N-N	N-N	N-N	N-N
Air Quality		1		S-S	S-S	S-S	S-S	S-S	S-S	S-S
Geology and Topography	General	1		N-N	N-N	N-N	N-N	N-N	N-N	N-N
	Seismology	1		N-N	N-N	N-N	N-N	N-N	N-N	N-N
	Economic geology	3		NN	NM	NM	N-N	N-N	N-N	N-M
Soils	Erosion hazard	5		M-M	M-M	M-M	M-M	M-M	M-M	M-M
	Rehabilitation potential[c]	5		M-M	M-M	M-S	M-M	M-H	M-S	M-S
Water Resources	Quality	5		S-S	S-N	S-S	S-S	S-S	S-S	S-S
	Demand	1		SS	SS	SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	4		S-M	S-M	M-S	S-M	S-M	M-M	M-M
	Acres disturbed (permanent)	6		S-M	S-M	M-S	M-S	S-M	S-M	S-M
	Acres disturbed (temporary)	6		S-M	S-M	M-S	M-S	S-M	S-M	S-M
Wildlife	Terrestrial	9		S-M	S-M	S-H	S-S	M-H	M-H	S-H
	Aquatic	2		S-S	N-N	N-N	N-N	N-N	N-N	N-N
Ecological Interrelationships	Terrestrial	9		S-M	S-M	S-H	S-S	M-H	M-H	S-H
	Aquatic	2		N-N	N-N	N-N	N-N	N-N	N-N	N-N
Paleontology		3		S-M	S-S	S-S	S-S	S-S	M-H	M-H
Archaeology		8		M-M	M-M	S-M	M-M	M-H	M-H	M-H
History		5		M-H	M-M	M-M	S-S	M-H	M-H	M-H
Recreation	General	3		S-S	S-S	M-H	M-M	M-H	M-H	M-H
	Scenic values	6		M-H	M-H	M-H	M-M	S-H	M-H	M-H
	Natural values	6		M-H	M-H	M-H	M-M	S-H	M-H	M-H
Land Uses	Miles of new corridor (more or less than prop.)	10		+24	-7	-22	+54	+70	+131	154
	Wood Products	1		S-S	S-S	S-S	S-S	S-S	S-S	S-N
	Agriculture	1		N-N	N-N	N-N	N-N	N-N	N-N	N-N
Socio-Economic	Housing and services	1		M-M	M-M	M-M	M-M	M-N	M-N	M-N
	Culture and attitudes	5		M-H	M-M	M-M	S-S	M-H	M-H	M-H

[a]Impacts rated as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

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FIGURE VIII-4

Impact Evaluation of Alternate Routes for Proposed Mohave to Serrano Route[a]

		Importance to decision making[b]	Sheephole Pass	Bristol Mountains	Ward Valley East	Martinez Canyon	Devers Serrano	BLM Ward Valley	North Indio Hills
Mileage (more or less than proposed route)		5	-29	-15	+1	+12	+5	+11	+2
Climate		1	NN	NN	NN	NN	NN	NN	NN
Air Quality		3	SS	SS	SS	SS	SS	SS	SS
Geology and Topography	General	1	SS	SS	SS	SS	SS	SS	SS
	Seismology	2	MM	MM	SS	MM	MM	MM	MM
	Economic geology	1	NN	NN	NN	NN	NN	NN	NN
Soils	Erosion hazard	2	SS	SS	SS	MM	SS	SS	SS
	Rehabilitation potential[c]	1	SS	MM	SS	MM	SS	SS	SS
Water Resources	Quality	2	SS	SS	SS	SS	SS	SS	SS
	Demand	0	SS	SS	SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	1	SS	SS	NN	NN	NN	NN	NN
	Acres disturbed (permanent)	3	SS	SS	SS	SS	SS	SS	SS
	Acres disturbed (temporary)	3	SS	SS	SS	SS	SS	SS	SS
Wildlife	Terrestrial	8	MM	MM	MM	MM	MM	MM	MM
	Aquatic	1	NN	NN	NN	SN	SS	SS	SS
Ecological Interrelationships	Terrestrial	8	MM	MM	MM	MM	MM	MM	MM
	Aquatic	1	NN	NN	SN	SS	SS	SS	SS
Paleontology		2	NN	SS	SS	SS	SS	SS	SS
Archaeology		6	SS	SS	SS	SH	SS	SS	SS
History		3	SS	SS	SS	SH	SS	SS	SS
Recreation	General	8	MM	MM	MM	MH	MM	MM	MM
	Scenic values	10	MM	MH	MH	MH	SM	HM	SM
	Natural values	8	MM	MH	MH	MH	MS	MM	SS
Land Uses	Miles of new corridor (more or less than prop.)	8	+125	+38	+99	+77	-56	+12	+34
	Wood Products	0	NS	NS	NN	NN	NN	NN	NN
	Agriculture	2	SS	SS	SS	SS	SS	SS	SS
Socio-Economic	Housing and services	2	+MM	+MS	+M+M	+MS	+M+M	+M+M	+M+M
	Culture and attitudes	4	MH	MH	MM	MS	MH	MM	SM

[a]Impacts rated as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

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Direct current and alternative voltage levels

The proposed system of two 500 kV alternating current (ac) lines was compared with four 345 kV ac lines, one 600 kV ac line, one 765 kV ac line, two 600 kv direct current (dc) lines, and two 765 kV ac lines. Construction of four 345 kV lines would double environmental impacts (land area occupied, and vegetation and wildlife disturbance). One 600 kV dc line could carry the necessary energy; however, it cannot be integrated into an ac system without ac converters. One 765 kV ac line would require taller and wider towers than a 500 kV ac line, thereby creating increased visual impacts. Both the two 600 kV dc and the two 765 kV ac lines would carry all the Kaiparowits power plant proposed generation plus an additional 2,000 MW. The larger capacity towers would create additional visual impacts.

Use of existing transmission systems

Kaiparowits to Eldorado route

The existing single circuit line would be upgraded to double circuit towers. Double circuit towers are taller than single circuit towers; therefore visual impacts would be increased.

Kaiparowits to Phoenix

This alternative would involve either upgrading two 500 kV lines to one 765 kV line with one 500 kV line left in place, or upgrading one existing 500 kV line to double circuit 500 kV towers. Soil disturbance would be increased during tower reconstruction. The greater mass of 765 kV towers would be more intrusive on the landscape. Systems reliability would be reduced, and construction costs would double.

Glen Canyon Dam to Pinnacle Peak substation

Soil disturbance would not be any greater than new construction.

Construction costs would increase four times over new construction due to disassembly of existing lines.

Kaiparowits to Mohave

An existing 500 kV line would be upgraded to a double circuit 500 kV line. Severe soil disturbance could be caused during disassembly of existing lines. There would be a decrease in system reliability.

Undergrounding

Placing the transmission lines underground would increase costs 10 times. Also, undergrounding of 500 kV ac and higher voltages is not technically feasible due to overheating problems. Undergrounding would eliminate visual impact, but would involve surface disturbance because of the need for a trench.

Line spacing

A line spacing closer than 2,000 feet would reduce the number of disturbed acres, but system reliability could be reduced.

Limestone quarry

Alternate surface mining methods

Several methods for extracting limestone from the quarry area were considered. However, regardless of the alternative used, impacts would be the same as those discussed in Chapter III on the Limestone Quarry.

Alternate access roads and limestone transportation routes

An alternative access route from the county road to the quarry would disturb the Utah prairie dog and would not be considered a viable alternative. Three alternate highway haulage routes were considered. The East-Widtsoe Junction route would eliminate the need to haul material through Bryce Canyon National Park, but would be difficult to travel during winter months. The Paunsaugunt

Plateau route would also bypass Bryce Canyon National Park, but would result in scars that could be visible from the park. A third alternative would result in hauling through Bryce Canyon National Park.

Alternate methods of transportation of limestone

Limestone transportation by railroad or conveyor belt would require construction of a 60-mile route and would disturb an additional 400 acres. Slurrying and pumping limestone would require about 175 acre-feet of water annually. Water in the slurry may affect the limestone, causing a reduction in its binding characteristics and lowering its effectiveness in the SO_2 scrubbers. Crushing and grinding limestone at the quarry site would reduce needed highway transportation. This method would require a large water system, an electrical transmission line and about 150 tons of coal per day hauled from Fourmile Bench.

Implementation alternatives

Regardless of the construction alternative considered, impacts to the natural environment would not be any different than those identified and discussed in Chapter III. Coordinating the employment of construction workers among all participants and components of the project would reduce social impacts.

Capacity greater than 3,000 MW

No specific plan has been presented by the participants for increasing the size of the proposed operation above 3,000 MW. However, studies by the participants indicate that up to 25,000 MW capacity could be built at the site without exceeding the 3-hour sulfur dioxide standard.

Site Capacity Predictions*

Megawatt (MW) Capacity	Maximum SO_2 Grams/sec Emission	Estimated 3-hour Maximum Ground-Level SO_2 Concentrations Micrograms per Cubic Meter ($\mu g/m^3$)
3,000	565	187
6,000	1,130	326
12,000	2,260	617
24,000	4,520	1,194
27,000	5,005	1,333

*Based on compliance with the most limiting 3-hour SO_2 EPA air quality standard.

Increased generating capacity would require several additional mines and more sophisticated mine planning and scheduling. In the absence of detailed mining plans it is estimated that ten to twelve mines would be required to meet the higher generating capacity at the Kaiparowits site.

Water-quality-impact differences between a 3,000 MW plant and a 6,000 MW plant would be increased diversion of water from Lake Powell, larger salt depositions from cooling tower drift, and increased trace elements in runoff. Withdrawal of 102,000 acre-feet of water per year from Lake Powell would increase the salinity of the Colorado River at Lee's Ferry less than 1 mg/ℓ.

The 102,000 acre-feet of water that would be diverted for possible use at Kaiparowits has been included in future development plans by the State of Utah and the Upper Colorado Region Comprehensive Framework Study. In 1973, consumptive water use of diversions by Utah from the Colorado River system was approximately 680,000 acre-feet out of a total allocation of approximately 1,350,000 acre-feet.

Greater quantities of limestone would be required in rock dusting the coal mines and to mitigate SO_2 emissions from a 6,000 MW power generating facility. Limestone quarrying operations would increase production to approximately 3,000 tons per day. Requirements for manpower, equipment, and the amount of highway transportation would also increase. As production level increased, there would be a corresponding increase in surface disturbance and excavation.

Alternative of constructing plant at Nipple Bench

Physically, the generating plant which would be constructed at the alternate Nipple Bench site would be similar to the Fourmile Bench proposal. Generating capacities would be the same. Space occupied by various components of the generating plant would be similar; but, due to the site configuration, the acreage permanently occupied by the generating plant at the Nipple Bench site would be somewhat greater - 1,077 acres compared to 932 acres for the Fourmile Bench site. The area permanently occupied by the water line and ancillary features would be less - 120 acres for the Nipple Bench site versus 225 acres for the Fourmile Bench site.

Construction of the power plant on Nipple Bench would have no significant effect on the proposed coal mine other than possible relocation of facilities to direct movement of coal to the south toward Nipple Bench, instead of to the northwest. Construction and operation schedules and plans would be essentially identical. If the Nipple Bench generating site were to be used, coal transportation could be by conveyor belt, railroad, or slurry pipeline. The participants have proposed railroad transportation as a possible alternative.

Two Utah Power and Light 138 kV power line alternatives have been selected to supply power to the mine. They would permit running a stub line to the Nipple Bench site for power during construction. One power line would begin at the existing (UP&L) substation north of U.S. Highway 89 near the Paria River, run easterly to the Nipple Bench site, thence northward to the coal mine, about 26 miles. About the same length as the route proposed in Chapter I, this alternative would disturb 28 acres. The second alternative would be a 138 kV line beginning at a new UP&L substation to be constructed near Glen Canyon City and running northward past the power plant construction site to the coal mine. The length would be about 18 miles, and the line would disturb 20 fewer acres than alternative one, but it would go through part of the proposed new town.

Description of environment - Nipple Bench site

The Nipple Bench site is located 14 miles south-southwest of Fourmile Bench at an elevation of 5,200 feet. It is approximately 21 miles northwest of the Navajo generating station and approximately 1,000 feet above the station. There is no sharp relief within the immediate vicinity of the Nipple Bench site. However, elevated terrain rises approximately 1,000 feet above the site within 6 to 12 miles northeast and east, with additional high terrain within 30 miles to the west, north, and east.

Small differences in relative humidity, precipitation, and evapotranspiration exist between Nipple Bench and Fourmile Bench. Fourmile Bench does have much lower cold weather temperatures than Nipple Bench both for extreme minimums and monthly means. The temperature differential between the two sites decreases during the warm season. Differences in surface winds between the two sites are minor. Prevailing upper winds are southwesterly at Nipple Bench and westerly at Fourmile Bench. Atmospheric stability in the lowest 3,000 feet above the surface is very similar between the two sites, although dispersion-enhancing turbulence appeared to be consistently lighter at Nipple Bench. Stagnation conditions, which include prolonged limited mixing conditions and low wind speeds, are expected to occur with a slightly greater frequency at Nipple Bench than at Fourmile Bench.

Meteorological conditions and predicted emission rates which would influence air quality impacts do not differ significantly from Fourmile Bench. Predicted ground level concentration for both sites would be similar as are calculated plume opacity and effects on visibility. Cooling tower fogging potential and drift rate would be similar at both sites. The proposed Nipple Bench site is 1,000 feet lower in elevation than the Fourmile Bench site with slightly greater potential for plume entrapment by elevated inversion layers. The Nipple Bench site is approximately 15 miles closer to the operating Navajo generating station and the potential for plume interaction with the Navajo plant would be greater

but still low in probability considering the necessary simultaneous and sustained occurrence of meteorological conditions necessary for interaction.

There are no known coal beds underlying Nipple Bench even though the geology is primarily the Straight Cliffs formation. Soils belong to the Badland-Rockland soil association. Nipple Bench is drained by intermittent streams which are subject to intense flooding after thunderstorms. The only perennial water sources are two small springs with a maximum discharge of less than 10 gallons per minute.

Two major vegetation types occur on Nipple Bench, blackbrush and a mixed shrub-grass association. There are no unique plants; however, one known population of a threatened plant, Peteria thompsonae, occurs north of the proposed plant site. Wildlife on Nipple Bench consists primarily of small, non-game species.

Nipple Bench exhibits fewer fossils than does Fourmile Bench. Thirty-five archaeological sites have been recorded within or near the proposed plant site. There are no known sites of historical value.

Recreational use is very limited. Livestock grazing is the only commercial land use.

Environmental impacts

Impacts on the environment of power plant construction and operation at Nipple Bench as compared with the site at Fourmile Bench are presented in Figure VIII-5 .

Four alternatives were examined which would permit the use of the Nipple Bench site as one of the terminals to proposed transmission line alternatives. There would be no environmental impacts beyond those already described.

Other alternative generating sites - Kaiparowits Plateau

The participating companies considered 17 locations in the Kaiparowits Plateau area as alternative generating station sites. Four sites close to Lake

FIGURE VIII-5

Site Comparison Study - Fourmile and Nipple Bench Environmental Considerations

Factors	Fourmile Bench Site		Nipple Bench Site	
Average annual rainfall	8 to 9 inches		7 to 8 inches	
Frost-free days	150		160	
Potential evapotranspiration	27 to 30 inches		30 to 33 inches	
Prevailing winds	Southwest and west		Southwest and west	
Elevation of plant site	6,200 feet above mean sea level		5,200 feet above mean sea level	
Stack height	600 feet		800 feet	
Stack emissions and rates	Similar for both sites			
Predicted ground level concentrations (fumigation conditions)	µg/m³	ppm	µg/m³	ppm
Particulates				
Annual	1		1	
24-hour	10		9	
Sulfur dioxide				
Annual	2	0.009	2	0.001
24-hour	45	0.020	41	0.018
3-hour	181	0.080	166	0.069
Nitrogen dioxide				
Annual	15	0.0080	15	0.0080
Stagnation episodes	2 to 3 episodes per year		Slightly higher	
Average stagnation episode	5 to 7 days		5 to 7 days	
Predicted plume opacity	11 percent		13 percent	
Emission effects on visibility	Similar for both sites			
Potential for plume entrapment by elevated inversion layer and ground level effects from limiting mixing	Slightly greater potential at Nipple Bench than at Fourmile Bench			
Potential for plume interaction with elevated terrain	Greater potential at Nipple Bench than at Fourmile Bench			
Cooling tower plume rise	Similar for both sites			
Cooling tower fogging potential	Similar for both sites			
Drift rate from cooling towers	Similar for both sites			
Distance from Grand Canyon	76 miles		70 miles	
Distance from Navajo Power Plant	36 miles		21 miles	
Potential for plume interaction with Navajo Power Plant	Slightly greater at Nipple Bench, but low probability for both sites			
Total acres disturbed during construction	9,460		9,410	
Total acres occupied by structures and improvements after construction completed	7,320		7,460	
Change in annual sediment deposition into Lake Powell, compared to present conditions: During construction	+ 1.9 acre-feet		+ 1.7 acre-feet	
After construction	- 0.5 acre-foot		- 0.5 acre-foot	
Potential number of acres that could be adversely affected by salt deposition from cooling tower drift	1,375		865	
Potential percent reduction in vegetative cover	70 percent		50 percent	
50-year change in cumulative sediment deposition in Lake Powell, proposed compared to present conditions	- 26.0 acre-feet		- 12.9 acre-feet	
50-year change in annual sediment yield on area of salt accumulation, proposed compared to present conditions	+ 0.29 acre-foot		+ 0.08 acre-foot	

(continued)

FIGURE VIII-5 (Concluded)

Factors	Fourmile Bench Site	Nipple Bench Site
Types and potential numbers of wildlife that could be lost due to presence of the power plant after 50 years have lapsed	20 head of deer year long or 70 head of deer during the winter, and numerous small mammals, raptors, reptiles, birds and predators	Numerous small mammals, reptiles, and a few birds
Loss of unique biological features	Pinyon and juniper trees at least 500 to 700 years old, one being over 1400 years old	Negligible
Impact on paleontological values	Encompasses the Kaiparowits formation that contains numerous fossils on 13 sites	Encompasses the Wahweap and Straight Cliffs sandstones that contain three sites with fossil fragments of turtle shells, dinosaur bones, and crocodile teeth
Impact on archaeological values	50 archaeological sites recorded, 30 within proposed plant site, and 20 within half-mile buffer zone, reflecting limited and specialized activities. 7 would be disturbed.	35 archaeological sites, 15 within proposed plant site and 20 within half-mile buffer zone, exhibiting complex associations of features and artifacts. 5 would be disturbed.
Effect on surface water quality	The effect would be the same regardless of the site chosen.	
Effect on ground water quality	The effect would be the same for both sites, as the ground water would be influenced by the mining operation on John Henry Bench and the new community on East Clark Bench.	
Loss of livestock grazing	740 AUM's per year	948 AUM's per year
Visibility of power plant, indicating aesthetic impact on region	Power plant complex in full view from Bryce Canyon National Park, 32 miles away. Top of stack visible from Page, Arizona, 32.5 miles away. None of power plant complex visible from Glen Canyon City, Utah, or Warm Creek Basin and Wahweap Marina on Lake Powell.	Top of stack visible from Bryce Canyon National Park, 40 miles away, Page, Arizona, 18.5 miles away, and Highway U-89, 10 miles away. Top of stack may also be visible from some portions of Lake Powell. None of power plant complex visible from Glen Canyon City, Utah, or Warm Creek Basin and Wahweap Marina on Lake Powell.
Coal underlying power plant site that would be lost during life of project	92 million tons	Negligible
Potential loss of wood products due to location of power plant	1,170 acres of trees suitable for firewood and posts	None
Potential impact on agricultural lands	There are no lands of agricultural value on Fourmile Bench or Nipple Bench.	
Access highway needed	67 miles	71 miles
Access roads for pipeline and power plant needed	60 miles	45 miles
Water pipeline needed	32 miles	19 miles
Change in elevation from coal mine to power plant site	+ 1,200 feet	+ 200 feet
Conveyor way needed	13 miles	14 miles
Rock tunnels needed	0.6 miles	1.2 miles
Transmission lines to be built	1,457 miles	1,443 miles

Powell were favored for consideration by the companies in 1964. Subsequent discussions with the National Park Service, passage of the Clean Air Act (1970), and meteorological studies of these sites prompted the companies to consider sites on nearby benches. A site on Nipple Bench was favored by the companies but was not acceptable to the Secretary of Interior (June 1973). Environmental concerns included the site's proximity to Glen Canyon National Recreation Area, Lake Powell, and Navajo power plant. Four other sites on more remote benches were analyzed by the participants (November 1973) to determine their suitability for a power plant. These sites were John Henry Bench, Dry Bench, Horse Flat, and Fourmile Bench (proposed site). Since the three alternative sites have many similarities to the proposed site and are also within the plateau, most of the impacts reported for the plateau impact area in Chapter III would also occur if the plant were located at any of these alternative sites. Any site-specific impacts such as loss of vegetation and archaeological remains would occur at the alternative plant site rather than at the proposed site. None of the three alternative plant sites have an advantage that would markedly reduce environmental disturbances if they were selected as the site for the proposed generating facility.

Alternate generating station sites outside Utah

Sites for coal-fired power plants in California, Arizona and Nevada were considered as alternatives to the Kaiparowits power plant. New coal-fired plants cannot be built in California unless there is a reduction in either air quality standards or present sources of pollution.

To increase capacity of coal-fired power plants in Arizona and Nevada would require additional water which is not presently available in the amount needed to meet increased generating capacity needs.

Alternate limestone quarry sites

Five alternate sites were considered. The best alternative to Johns Valley would be the Canaan Peak site. This alternative would eliminate the need to haul limestone through Bryce Canyon National Park. Also a less-diverse population of wildlife, containing fewer game animals and no known endangered species, would be affected if the Canaan Peak site were used rather than Johns Valley.

Alternate actions by government agencies

New town

Six new community sites were investigated. All sites had some limitations, but the East Clark Bench site appeared to be the most favorable. It is the only site, except the East Clark Bench alternate, that is now served by a paved all-weather highway. It has sufficient space for expansion and the best potential for attracting additional business and industry. The lower elevation, warmer climate and closer proximity to Lake Powell make it more attractive for a town site.

New highway

The Kaiparowits Planning and Development Advisory Council recommended a road from Cannonville to Glen Canyon City (East Clark Bench). The same route would be used whether the plant is located at Fourmile Bench or Nipple Bench. Alternatives would have the same impact to the environment as the primary proposal with exception of the alternate route up Last Chance Creek. The Last Chance Creek alternative would result in disturbance of tropic shales, which are highly erosive.

Alternate means of meeting project objectives

Purchase power from outside Kaiparowits market area

Purchase of power outside the Kaiparowits market area could only occur if surpluses were available or if utilities were willing to provide additional

capacity. Most utilities in the Kaiparowits market area will need additional generating capacity soon, even at radically slowed electrical-use growth rates. Utilities would find themselves competing for any available power outside the market area. Thus, buying and selling surplus power can be used as a short-term expedient, but cannot be considered a long-term alternative.

Oil and gas

Present California air pollution control regulations rule out the construction of any new fossil-fueled (oil, gas, coal) electric generating plants for the near future.

U.S. proven oil reserves amount to about a 9-year supply; the life of proven natural gas reserves in the 50 states at current use rates is 10 to 11 years. National shortages and dependence on foreign imports preclude oil and gas as realistic alternatives.

Oil shale and tar sands

Despite large reserves, commercial production of synthetic crude oil from shales or sands has not yet begun in the United States. Major problems have arisen in disposal of large amounts of solid wastes, economical extraction, and the use of large amounts of water in water-short areas. Oils produced must be burned in conventional fossil-fueled power plants in order to convert their energy into electricity. Particulates and sulfur emissions may be substantially lower than for a coal-fired plant.

Hydroelectric power

Hydroelectric power could be a viable alternative to the Kaiparowits proposal if suitable dam and reservoir sites could be found. High capital costs and large-scale changes in the environment are effects; hydroelectric plants use a renewable resource. Pumped storage units can take over some peak load generating capability. Southern California utilities propose to construct 6,673 MW of

hydroelectric capacity between 1972 and 1991, of which 3,600 MW would be pumped storage capacity. Several additional sites would have to be developed in order to produce 3,000 MW of base-load capacity. Environmental impacts would be large and not all beneficial.

Organic waste

Power generation from municipal wastes could produce part of the power needed in the Kaiparowits market area. Technology is available - recycling of metals and glass is possible; part of the solid waste disposal problem is solved. However, the potential power to be generated from municipal solid waste is small, and municipal solid wastes from Los Angeles County would be able to provide only about 5-1/2 percent of the heat value needed for a 3,000 MW plant. Environmental impacts would be about the same as for coal-fueled plants. This would rule out the construction of a coal-fired, municipal waste-assisted plant in the Los Angeles area. The low heat value of municipal waste would rule out shipping it long distances to plants outside the market area.

Coal gasification

The gasification of coal would provide synthetic natural gas which would be burned elsewhere. The production of synthetic natural gas having the same heat value as the coal needed to fire a 3,000 MW power plant would require about 1-1/2 times as much coal and 40 percent of the water. It would produce about 85 percent of the ash, 22 percent of the particulates, 32 percent of the SO_2, and about 8 percent of the nitrogen oxides that the Kaiparowits plant would produce with air emission controls in operation. If the gas were to be converted into electricity, a 3,000 MW gas-fired plant would be constructed which would use about the same amount of water as a coal-fired plant and which would discharge about the same amount of NO_x as a coal-fired plant. Present regulations preclude construction of such a plant in southern California. However, part of the gas could be diverted

to direct heating, and a coal-gasification plant could produce salable quantities of sulfur, phenols, naphtha, tar oils, tar, and anhydrous ammonia. Although this alternative is technologically feasible, there is doubt that it would be commercially attractive.

Nuclear power

The alternative of using nuclear power to generate electricity is economically feasible, but questions of proper siting, design, operation, transportation and reprocessing of fuels, and storage of waste products remain unanswered to the satisfaction of many persons. Although the applicants have investments in proposed nuclear developments, they consider them to be supplementary to the proposed Kaiparowits plant rather than altneratives to it. The State of California has concluded that nuclear plants will be needed to produce half of the electrical power needed to meet the demand during the next 20 years.

Geothermal

Geothermal energy may be considered an alternative for part of the power to be generated by the Kaiparowits plant, and the proponents have substantial investments in exploration and development of geothermal sites. However, recoverable amounts of energy from geothermal sites may prove to be rather small. Use of geothermal energy for generating 3,000 MW is not a technically feasible alternative at this time.

Solar energy

Recent nationwide interest in solar energy may hasten the development of solar energy sources which may eventually supplement, and even replace in some cases, conventional generation of electricity; however, delays in implementing presently feasible methods, whether large-scale or on a single-residence basis, preclude consideration of solar energy as a feasible alternative generating 3,000 MW at present or in the near future.

Investments in energy conservation services

Conservation programs require public, governmental and company cooperation; long-term planning on a national and regional basis is needed to bring about long-term changes in consumption patterns. If this cooperation was in effect now, construction could be deferred 10 years. If it took 5 years to develop this cooperation, the power plant could be deferred 5 years. Construction of the Kaiparowits coal-fired generating plant could not be replaced by adoption of energy conservation measures.

Advanced generation and transmission systems

Due to technical problems, none of the advanced generation and transmission systems would be available soon enough to either be incorporated in or offset construction of the Kaiparowits power plant.

<u>Delay or denial of proposed actions</u>

Moratorium on proposal until regional energy planning completed

If regional energy planning involving state, federal, and local governments was initiated, the Kaiparowits power plant probably would be delayed 2 to 3 years.

Effects of delay

The Kaiparowits area would continue, without much change, the same industries and activities as it has in the past. Reserve generating capacities would be substantially reduced, in some cases to less than half of the 18 to 20 percent margin that utilities like to maintain. This would reduce system reliability. More time would be available for a regional energy study or for improvements in scrubber technology. Oil-fired generating plants scheduled to be replaced by the Kaiparowits project would continue to operate.

Denial of proposed actions

The participants would be forced to look to other areas and sources of energy and possibly a reduction in consumption of electricity in the market area. The Kaiparowits area would continue with the same industries and activities.

If construction of the Kaiparowits power plant was denied, 102,000 acre-feet of water would still be allocated to the proponents until the allocation was transferred to other hands. It could then be used for other power or chemical projects or for agricultural purposes.

The coal in the Kaiparowits area could be used for coal gasification and related petrochemicals.

INTRODUCTION

This chapter is organized as follows: First are technical alternatives or modifications to the project as proposed. The basic project remains unchanged. Second are alternative site locations. These range from Nipple Bench, which is close to the proposed site, to sites in other states. Next are different methods of meeting the same project objectives, such as using nuclear power to generate electricity. Finally the effects of delay or denial of the project are considered along with the subsequent alternate uses of water and coal.

TECHNICAL ALTERNATIVES

Generating plant designs

Site arrangement

The proposed site arrangement was established by the participants, using construction and operating constraints as well as physical and environmental considerations. However, it is possible that changes in location of various components might occur during final design engineering. These changes would not increase total size or basic area required by each component. Since total area impacted by each component would be about the same regardless of arrangement, impacts evaluated in Chapter III would be similar to alternative site arrangements on Fourmile Bench.

Power block - stack lighting

One alternate stack marking scheme was evaluated against the proposed action which is strobe lights during daylight hours and red warning lights at night. The alternate scheme was a 24-hour strobe light with reduced intensity during night-time hours. The strobe lights can be seen at greater distances at night than the red lights. This would create a greater visual impact during nighttime hours.

Particulate and sulfur dioxide (SO_2) removal systems

Introduction

The participants have made a commitment to attain the following level of emission control:

1) 99.5 percent particulate removal

2) 90.0 percent sulfur dioxide removal

An extensive survey by Bechtel Power Corporation (Bechtel, 1974) for the participants, was made on particulate and SO_2 removal systems for meeting applicable government regulations regarding plume opacity and allowable emissions. Four particulate removal systems and seven sulfur dioxide removal systems were evaluated (see Figures VIII-6 and VIII-7). This evaluation resulted in selection of the proposed system, discussed in Chapter I (a hot electrostatic precipitator followed by a wet lime SO_2 scrubber).

Particulate removal systems

Hot and cold electrostatic precipitators

If properly designed, both cold and hot precipitators can perform to Kaiparowits design criteria: i.e., 99.5 percent removal efficiency. However, more confidence in the efficiency and reliability of performance, greater flexibility in fuel variation, and ease of material handling can be expected from a hot precipitator for the Kaiparowits low sulfur coals. Impacts from the use of cold electrostatic precipitator would be the same as for a hot precipitator as discussed in Chapter III.

Baghouse

Baghouses are simply porous fabric filter bags housed in a large structure. When dust-laden gases pass through these filters, particulate matter is collected by the bag fabric and then removed by a certain dust-dislodging step. The particulate removal capability of a baghouse can be expected to exceed 99.5 percent with additional removal of submicron particulates. Baghouses would require two to three

FIGURE VIII-6

Summary of Alternate Particulate and SO_2 Abatement System
(Particulate Removal System)

	Hot Precipitator	Cold Precipitator	Baghouse	Venturi
Meets Kaiparowits 99.5% Particulate Removal Design Criteria	yes	yes	yes	yes
Meets Kaiparowits 90% SO_2 Removal Design	no removal	no removal	no removal	--[a]
Type of System	dry	dry	dry	wet
Chemical Required Tons/Day	none	none	none	none
Major Products & Wastes Produced	1,820 ton/day fly ash	1,820 ton/day fly ash	1,820 ton/day fly ash	1,820 ton/day fly ash
Stages of Development	full scale	full scale	small (80 MW) Comercial scale	full scale
Operational Reliability	good	good	good	fair

[a]Some removal

FIGURE VIII-7

Summary of Alternate Particulate and SO_2 Abatement System
(Sulfur Dioxide Removal System)

	ton/day						
	Lime/Limestone	Double Alkali	Wellman-Lord	Magnesium Oxide	Catalytic Oxidation	Copper Oxide	Additive Injection
Meets Kaiparowits 99.5% Particulate Removal Design Criteria	*	*	no removal	no removal	no removal	no removal	Creates Particulate
Meets Kaiparowits 90% SO_2 Removal Design Criteria	yes	yes	yes	yes	yes	yes	no
Type of System	wet, non-regenerative	wet, non-regenerative	wet regenerative	wet regenerative	wet regenerative	regenerative	dry non-regenerative
Chemicals Required Tons/Day	280 lime (CaO)	100 make-up soda (Na_2CO_3) and lime	50 Na_2CO_3	20 MgO	make-up V_2O_5 catalyst	make-up CuO catalyst	283 CaO or 490 limestone ($CaCO_3$)
Major Products & Wastes Produced Tons/Day	810 $CaSO_4$, $CaSO_3$ & $CaCO_3$	720 $CaSO_3$ & $CaCO_3$	70 $MaSO_4$ pure in soln. 140 sulfur	150 sulfur; 20 MgO	600 78% by wt. H_2SO_4	150 sulfur	830 $CaSO_3$, $CaSO_4$ & $CaCO_3$
Stages of Development	full scale	pilot plant	full scale demonstration	full scale demonstration	full scale demonstration	pilot plant	abandoned
Operational Reliability	good	not available	good	fair	poor	not yet available	poor

* - has some removal

times the area required by electrostatic precipitators. No large scale coal-fired generating station experience is available, and possible bag rupture which would create injurious health problems to employees and allow considerable fly ash to escape into the atmosphere. The impacts of a baghouse to the air quality would not differ from the impacts of a hot precipitator.

Venturi scrubbers

A venturi scrubber for particulate removal is a high energy wet scrubber. The flue gas and liquid are accelerated through the venturi throat, causing atomization of the scrubber liquid. Fast-moving solid particles penetrate into the water droplets and become wetted and agglomerated. Finally, they are removed in the form of a slurry.

Removal efficiency of a venturi scrubber is determined by particle size and pressure drops over the scrubber system. To obtain a removal efficiency of 99.5 percent at Kaiparowits, a pressure drop of 20 inches (water gauge) or higher may be needed.

Compared to electrostatic precipitators and baghouses, venturi scrubbers require less space. Fly ash would be removed in the form of a slurry. More power would also be needed for operation due to the high pressure drop requirement. This alternative would require greater fuel consumption in order to maintain the high pressure drop requirements and greater water consumption for the slurry. The Bechtel Power Corporation study does not quantify the increase in fuel and water consumption. The study only states that more electrical power and water are needed and it is less reliable than a hot precipitator. The unit is not any more efficient in removing particulates than the proposal (Bechtel, 1974).

Sulfur dioxide removal systems

Many SO_2 removal processes are under development. U.S. processes that are most developed are lime/limestone, double alkali, Wellman-Lord, magnesium

oxide, catalytic oxidation and copper oxide. Foreign processes have not been included because sufficient data are not available.

Limestone processes

The wet limestone scrubber process is a non-regenerative process which uses limestone ($CaCO_3$) as a chemical additive to remove SO_2 content from the flue gas stream. Overall reaction for limestone scrubbing is represented as follows:

$$CaCO_3 + SO_2 + 1/2H_2O \longrightarrow CaSO_3 + 1/2H_2O + CO_2$$

In the limestone scrubbing system, flue gas enters the scrubber where the necessary gas/liquid contact occurs for the chemical reaction (see Illustration VIII-1 The flue gas, with most SO_2 removed, emerges from the absorption section of the scrubber with some entrained slurry and passes through a mist eliminator to reduce mist and drift. Drift is entrained slurry.

Based on experience to date, both limestone and lime systems are expected to be capable of removing up to 90 percent of SO_2 from flue gases. The lime/limestone systems have provided successful operation of full scale units over extended periods of time and have shown capability of removing both particulates and SO_2.

Both lime and limestone are expected to give acceptable performance in the proposed SO_2 removal system. Use of lime is proposed by the participants because a full-scale module test at Mohave, demonstrated that lime is more efficient and causes fewer operating and maintenance problems than limestone. The limestone system would eliminate need for a kiln, associated baghouses, extra coal handling equipment, blowers, and 50 tons/day of coal for use in the kiln.

Double alkali process

The double alkali, or dual alkali process is a wet, throwaway process. Flue gas is scrubbed with a soluble alkali such as sodium sulfite, which is

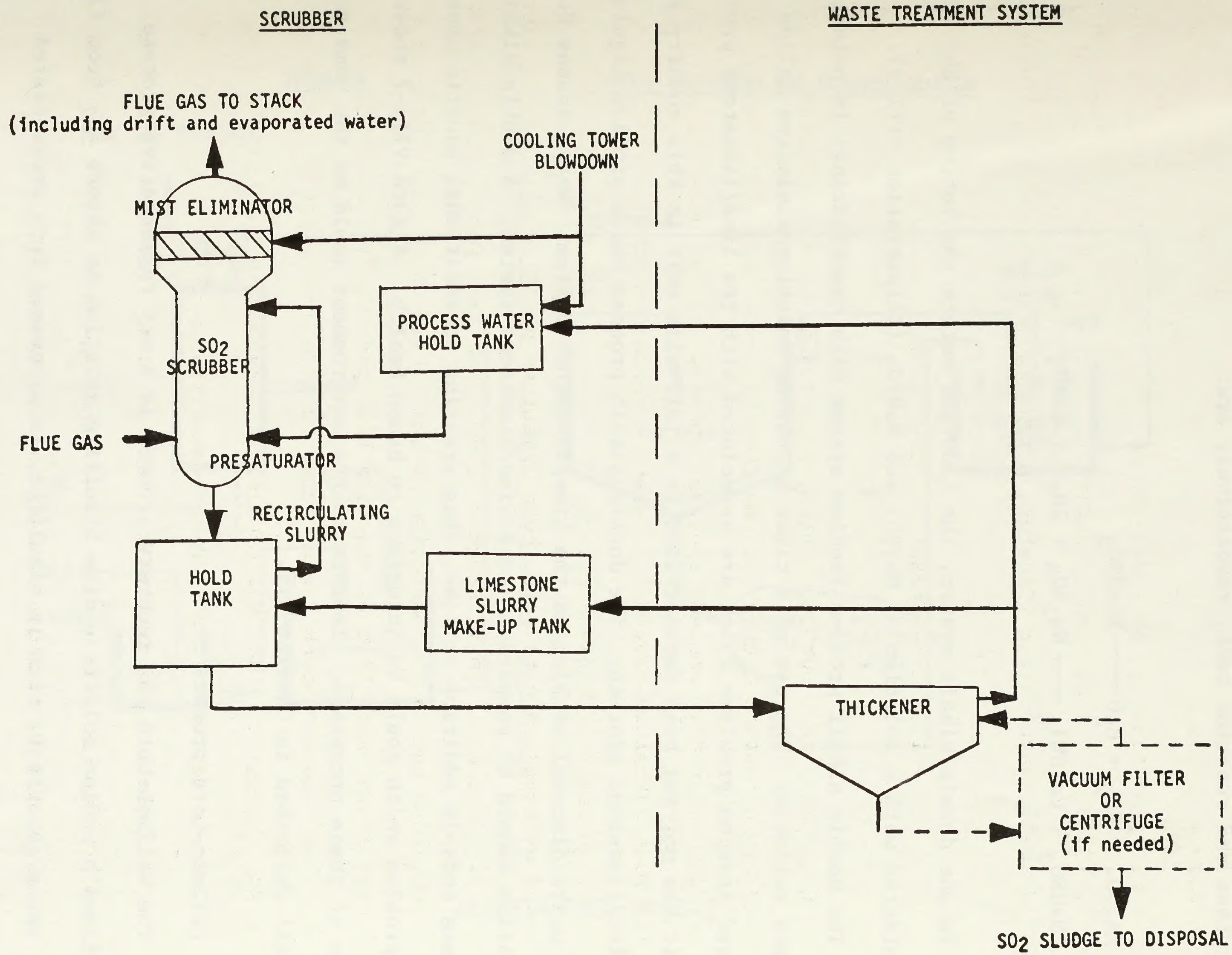

ILLUSTRATION VIII-1

Typical Limestone Process Flow Diagram

subsequently regenerated with an insoluble alkali such as lime. The insoluble solid produced, calcium sulfite, must be disposed of. Typical reactions occurring in the scrubber and reaction tank, respectively are:

$$NA_2SO_3 + SO_2 + H_2O \longrightarrow 2NaHSO_3$$
$$2NaHSO_3 + Ca(OH)_2 \longrightarrow Na_2SO_3 + 2H_2O + CaSO_3$$

In one double alkali system, the flue gas enters the bottom of the scrubber and is contacted with a solution of Na_2SO_3 and $NaHSO_3$ (Illustration VIII-2).

The double alkali process (sodium system with causticizing) is potentially workable and reliable. The use of a clear scrubbing solution minimizes solids build-up and erosion problems which are associated with the lime/limestone process. However, it has not yet been demonstrated in a full-size unit in this country as has the lime/limestone process. The double alkali process has a similar liquid and solid waste disposal problem as the lime/limestone system. Water losses due to evaporation should be comparable to a lime/limestone system. A double alkali process uses soda in addition to lime, thus creating an additional caustic chemical handling problem which could be injurious to human health. Figure VIII-7 shows comparison of these processes. Impacts to the environment would be the same as the proposal described in Chapter III.

Wellman-Lord process

The Wellman-Lord SO_2 recovery process is a wet regenerative process which utilizes a sodium sulfite-sodium bisulfite solution to absorb SO_2 from flue gas. The spent absorbent, rich in bisulfite, is processed in a steam-heated evaporator regenerating active sodium sulfite crystals and producing a concentrated stream of SO_2 for further processing, (Illustration VIII-3). The simplified process chemistry is:

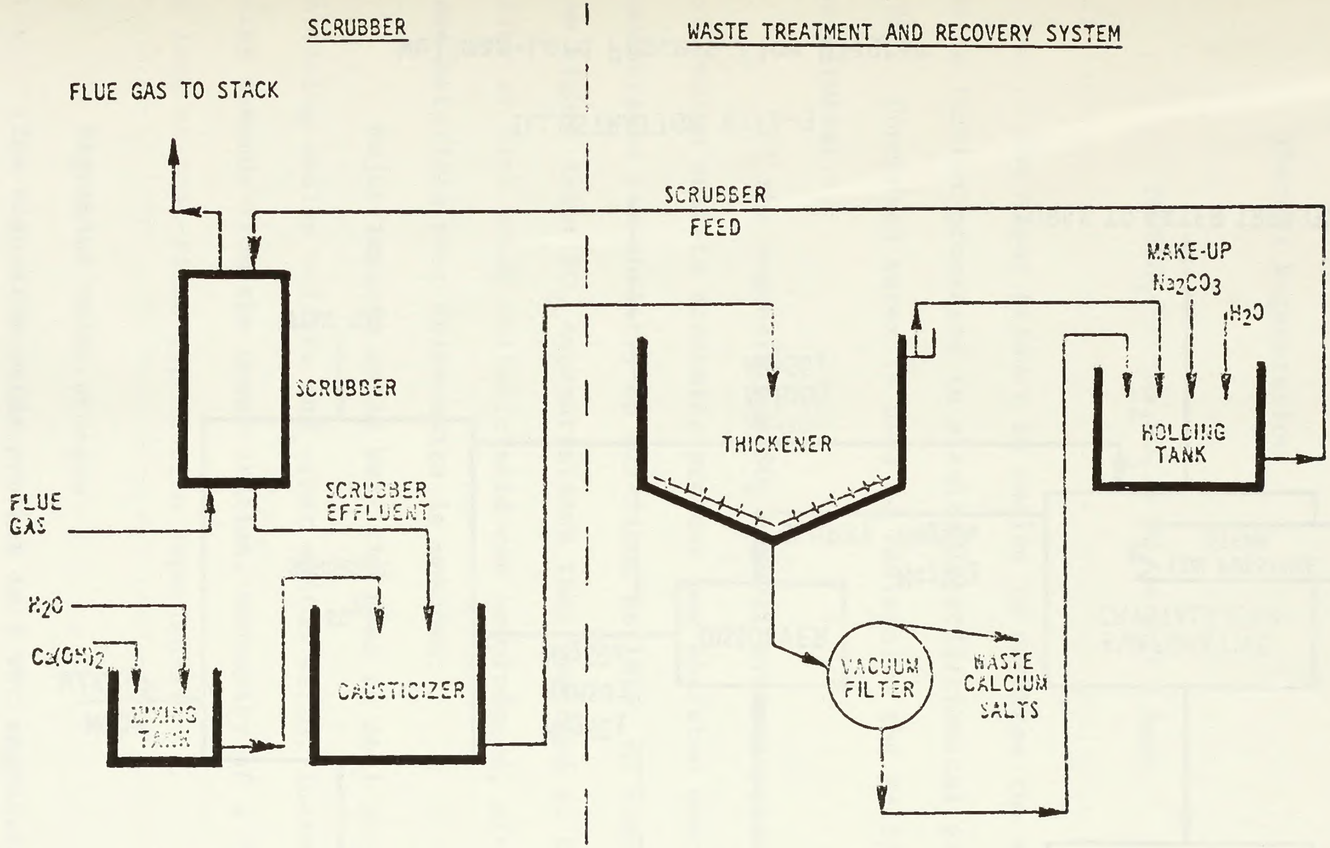

ILLUSTRATION VIII-2

Double Alkali Process Flow Diagram
Sodium Scrubbing With Lime Regeneration

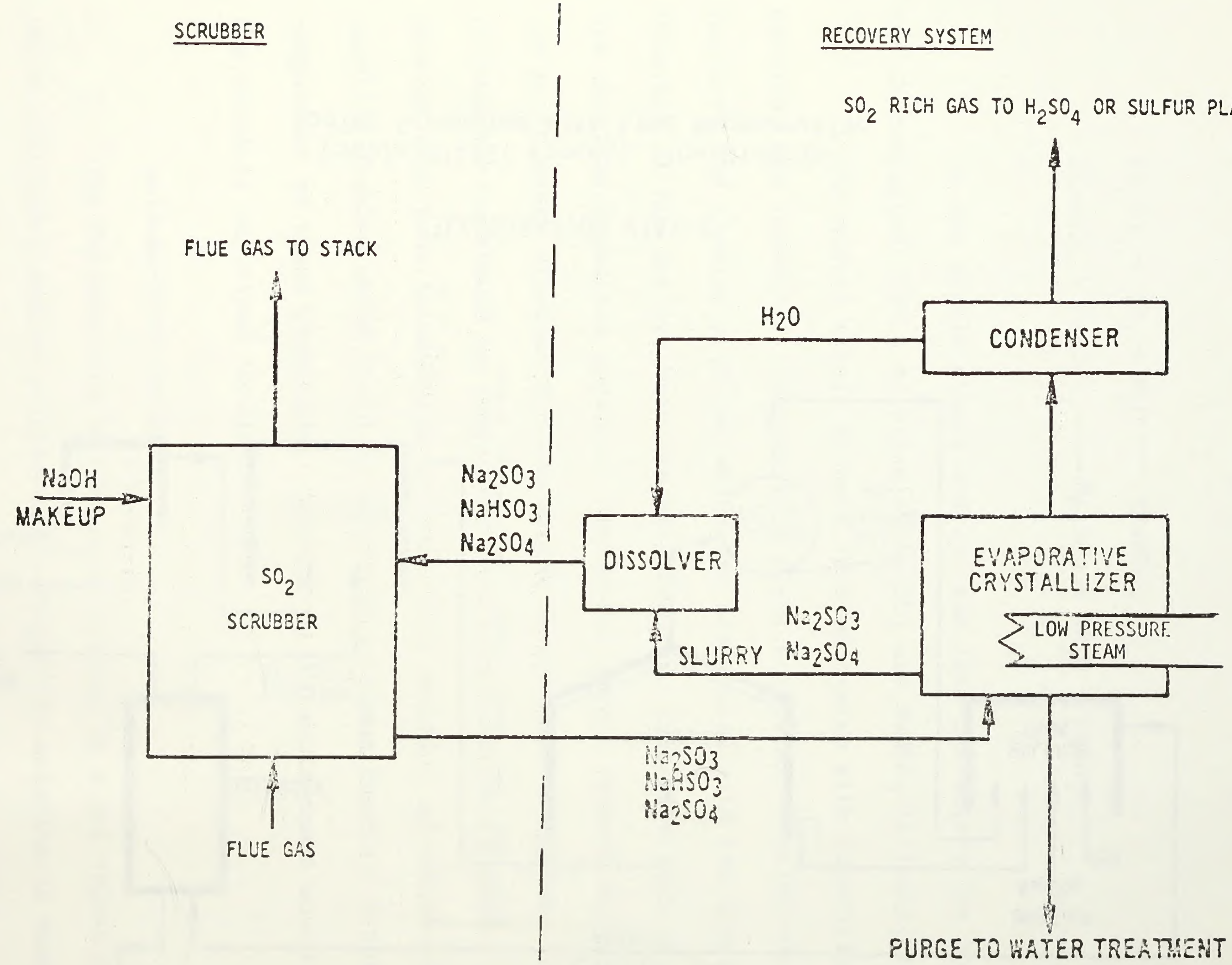

ILLUSTRATION VIII-3

Wellman-Lord Process Flow Diagram

Absorption by Sodium Scrubbing

$$SO_2 + Na_2SO_3 + H_2O \longrightarrow 2NaHSO_3$$

Thermal Regeneration

$$2NaHSO_3 \longrightarrow Na_2SO_3 + SO_2 + H_2O + \text{heat}$$

The vapor product is cooled to condense the water. The pure gaseous SO_2 can be further processed in a suitable acid/chemical plant to elemental sulfur or H_2SO_4. Condensed water is used to redissolve the sulfite solids for recycle to the scrubber.

Of the regenerative SO_2 removal systems presently available, the Wellman-Lord sodium sulfite scrubbing process has operated most reliably. The process has demonstrated the ability, on oil-fired boilers, to remove 90 percent of the SO_2 from higher inlet SO_2 concentrations than expected at Kaiparowits. Elemental sulfur or high grade sulfuric acid can be produced, although ability to market these materials near Kaiparowits is unknown.

Major impacts would be: the need to sell or dispose of a purge stream containing sodium sulfate and other sodium salts, increase of 3 to 6 percent in energy demands from the power station, necessity of a chemical regeneration plant, and lack of coal-fired application experience.

Magnesium oxide process

The magnesium oxide process is a wet regenerative process which uses a slurry containing magnesium oxide (MgO), magnesium sulfite ($MgSO_3$) and magnesium sulfate ($MgSO_4$) to remove sulfur dioxide. The SO_2 that is removed can be converted to 90 percent H_2SO_4 or elemental sulfur by a suitable acid/chemical plant.

In the process offered by the Chemical Construction Company, flue gas containing SO_2 and SO_3 enters a venturi absorber and contacts the absorbing medium, (Illustration VIII-4). SO_2 in the flue gas diffuses through the gas to the liquid and reacts with hydrated MgO.

$$MgO + SO_2 \longrightarrow MgSO_3$$

Long-term operating experience with coal-fired units is not available. Energy requirements would increase because of fuel needs for the dryer and calciner in addition to power needs of the scrubber. Also, an acid/chemical plant would be required and marketability of elemental sulfur or sulfuric acid in the Kaiparowits area is unknown. There would also be danger to human, animal, and plant life should acid spills occur.

Catalytic oxidation

The catalytic·oxidation process developed by Monsanto Environ-Chem Systems, Inc. is a wet regenerative process resulting in the production of a weak (78% concentration) sulfuric acid.

The chemical process occurs in two steps: the oxidation of SO_2 to SO_3 in the catalyst bed and the absorption of the SO_3 by a sulfuric acid scrubbing liquid (Illustration VIII-5).

Although the reliability of the catalytic oxidation system may be high, the process is presently not proven. The 42-inch water gauge pressure drop through the catalytic oxidation system is very high and causes a high energy consumption for the process, 600 tons per day of weak 78 percent H_2SO_4 is produced rather than the 98 percent H_2SO_4 from other regenerative processes, and the market for 78 percent H_2SO_4 is unknown for the Kaiparowits area. Operating experience such as the amount of catalyst lost during each cleaning is lacking.

Copper oxide process

Developed in the Netherlands, the Shell Flue Gas Desulfurization Process is a dry, regenerative process using copper oxide on alumina for absorption of SO_2

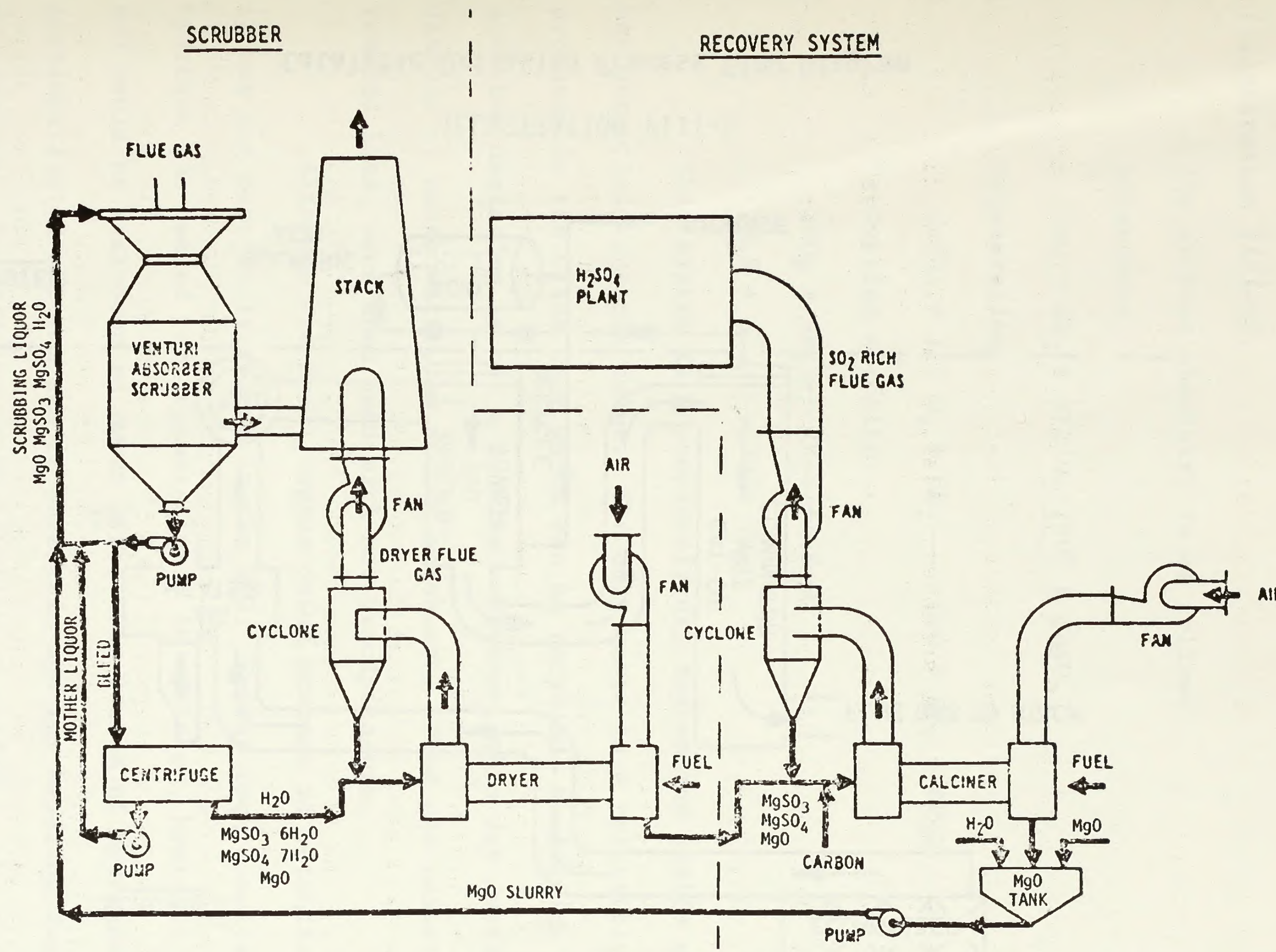

ILLUSTRATION VIII-4

Magnesium Oxide Slurry Process Flow Diagram
(Dryer Flue Gas Released To Stack)

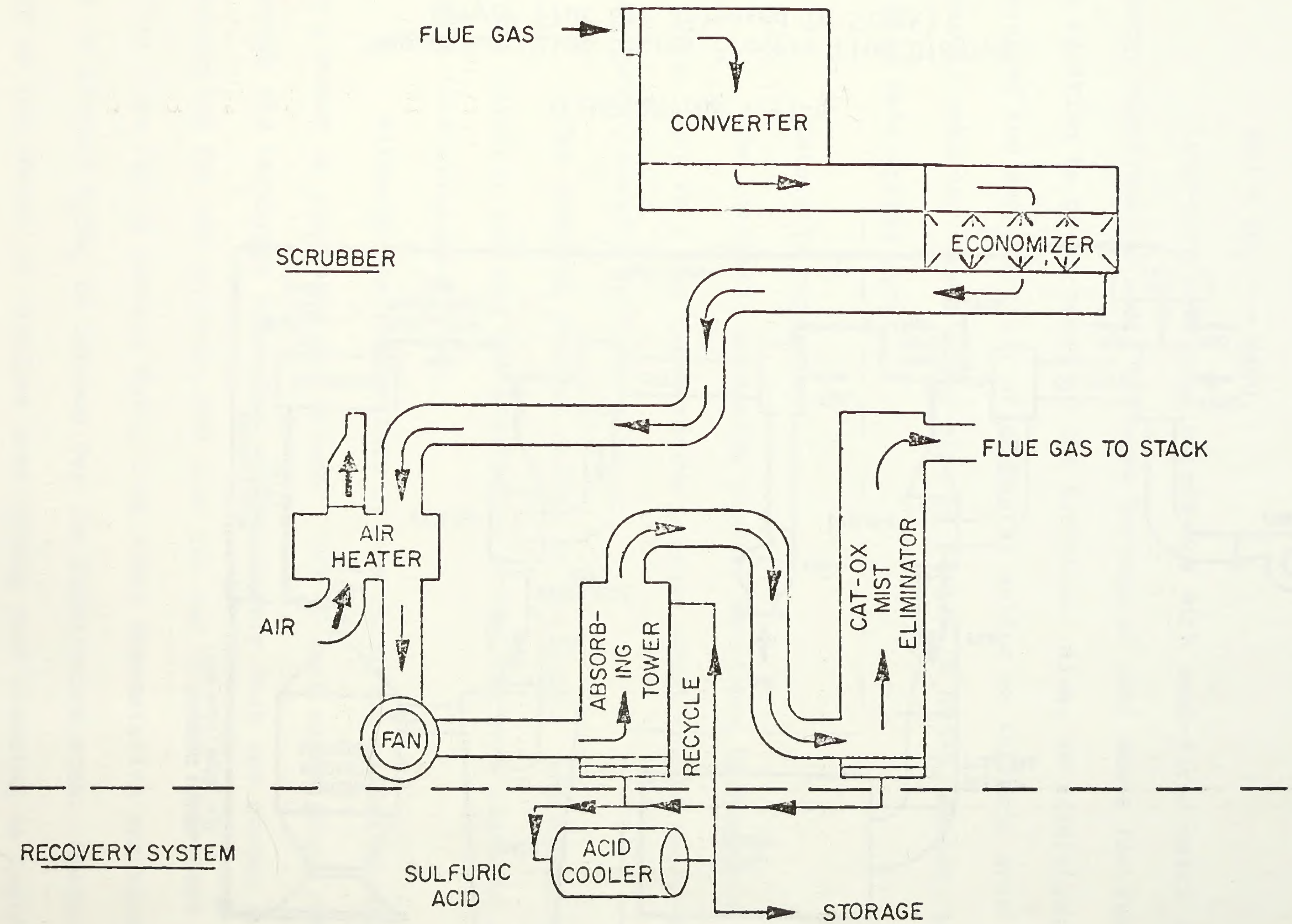

ILLUSTRATION VIII-5

Catalytic Oxidation Process Flow Diagram

from flue gas. Universal Oil Products (UOP) is the U.S. licensor. The process has four stages: absorption, regeneration, concentration, and sulfur production (Illustration VIII-6).

The process chemistry is as follows:

Acceptance

$$CuO + SO_2 + 1/2\ O_2 \xrightarrow{750^{o}\ F} CuSO_4$$

Regeneration

$$CuSO_4 + 1/2\ O_2 + 6H_2 \longrightarrow CuO + SO_2 + 6H_2O$$

Production of Sulfur

$$2SO_2 + 6H_2 \longrightarrow 2H_2S + 4H_2O$$

$$2H_2S + SO_2 \longrightarrow 3S + 2H_2O$$

This system is a completely dry system and yields elemental sulfur which has potential economic value. The only waste is a relatively easily handled gas produced by the Claus unit which can be recycled. No liquids are needed for absorption and thus demisting is not a problem. However, this dry system does not help dispose of waste water, as do wet scrubbers. Flue gas reheat may be required at reduced load, even when used with hot precipitators.

Although the Shell copper oxide process is potentially very promising, it has not been fully tested in the U.S. Energy requirements are high because of hydrogen gas needed for regeneration. In addition, hydrogen gas is very explosive and could be hazardous to human life. One source of hydrogen is natural gas, but availability of natural gas is uncertain and its handling requires adequate safety precautions. In addition, marketability of sulfur in the Kaiparowits area is unknown; there may be problems with plugging the copper oxide, and reliability is unknown because coal-fired boiler experience is not available.

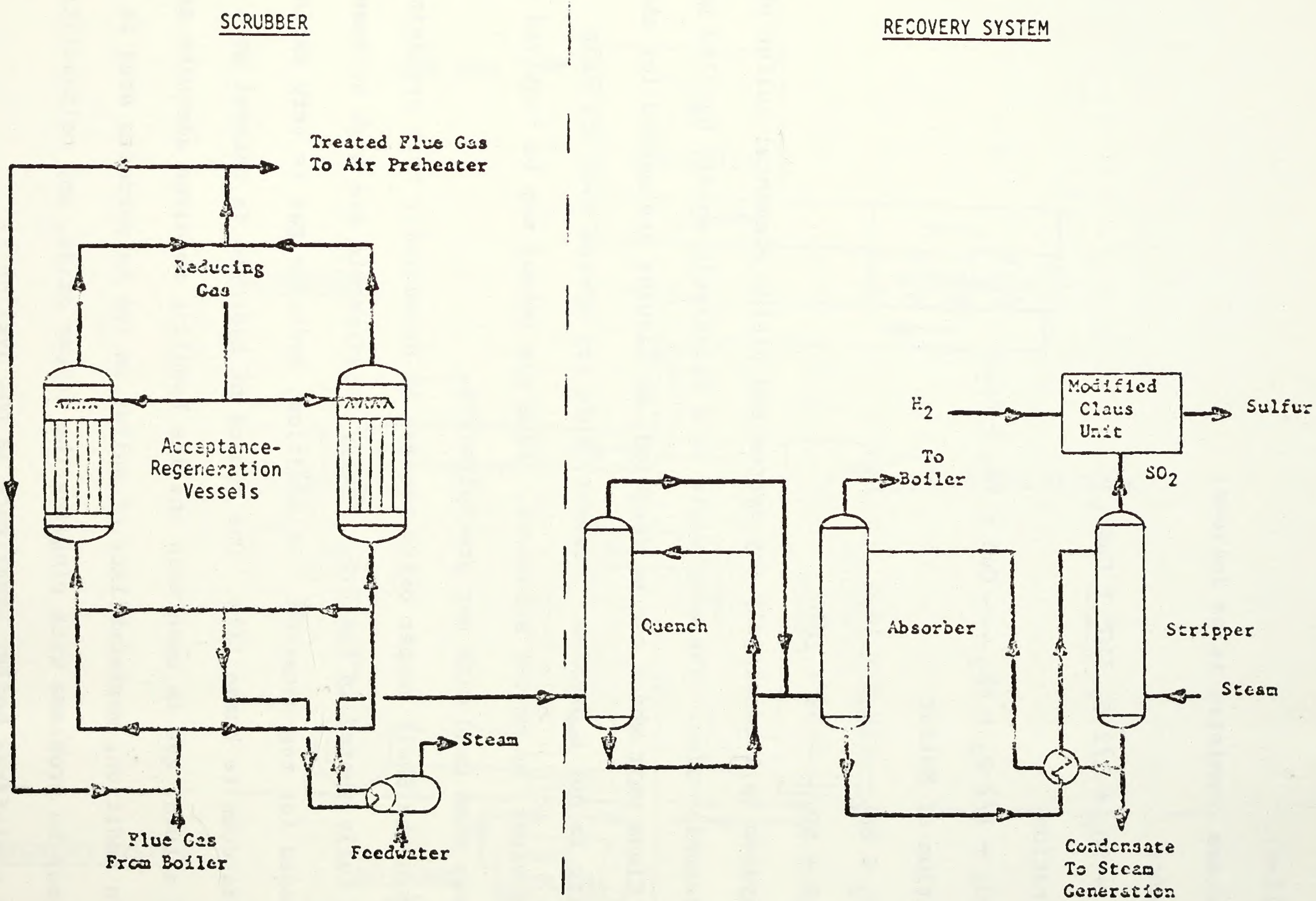

ILLUSTRATION VIII-6

Shell Copper Oxide Flue Gas Desulfurization Process Flow Diagram

Additive injection

The additive injection process is a nonregenerative process in which lime or limestone is injected into a boiler and the products subsequently removed by a wet scrubber, a dry baghouse or a dry electrostatic precipitator.

Because of operating problems, the process is not presently suitable for a large-scale utility boiler application. However, future progress in this area might change its suitability for Kaiparowits application.

A summary of the various alternate systems presently considered for the Kaiparowits generating station is presented in Figures VIII-6 and VIII-7. Future developments may alter the viability of alternate particulate SO_2 systems discussed herein. Therefore, flexibility would be allowed in final selection in the event that a particular alternate or combination of alternates becomes more attractive in the future.

Ash and scrubber waste disposal

At the proposed Fourmile Bench site, there is a local system of vertically-walled, deep-cut canyons. Fourmile Bench is a relatively flat area above these canyons and forms a portion of the overall plateau system known as the Kaiparowits Plateau. As a result of these topographic conditions, two basic alternatives for ash and sludge disposal have been considered. They are bench-top fill and canyon fill.

Bench-top landfill in southeast corner of proposed plant site

This alternate is II-B on Illustration VIII-7, and is similar in all aspects to the proposed landfill area described in Chapter I except for location.

This landfill site would be in the southeast corner of the Fourmile Bench site, approximately 1 mile from the power block area. The proposed site is relatively flat with a rolling drainage area immediately west of Wesses Canyon. The site would be at the crest of the tributary drainage area thus minimizing the

amount of floodwater drainage to the disposal area containment dikes or retention basin structures.

The pond to collect rainfall runoff would be approximately 49 acres in surface area. An earth dam approximately 35-feet high would be built to retain 430 acre-feet (140 million gallons) of storm runoff. Material for the dam would come from the interior of the landfill site and would require 171,000 cubic yards of excavation. It is anticipated that the dam would consist of dense sandstones for ballast with a relatively impervious core made of mudstone from the disposal area.

This alternative would require an additional 4,000 cubic yards of excavation, or an increase of 2.3 percent over the proposed action, which might cause greater surface disturbance and increase the problem of sediment in surface waters. However, less than half of the site (230 acres) would be affected by salt drift from cooling towers with none of the 1,400-year old pinyon-juniper trees being affected.

Bench-top landfill waste disposal alternative

Another alternative to bench-top landfill waste disposal would be to place the waste in a disposal area similar to that used at the Navajo generating station. At Navajo the wastes are deposited in an area at the base of a high bluff. Downstream end of the waste disposal area is surrounded by a berm to prevent runoff water from flowing to Lake Powell.

Wastes are placed and compacted adjacent to the berm and are spread evenly over the area to produce an engineered fill behind the berm.

This alternative would be similar to the proposed bench-top fill except that a dam and runoff evaporation pond would not be used. Placement and compaction of the solid wastes would result in rainfall runoff being contained on the compacted solid waste mixture.

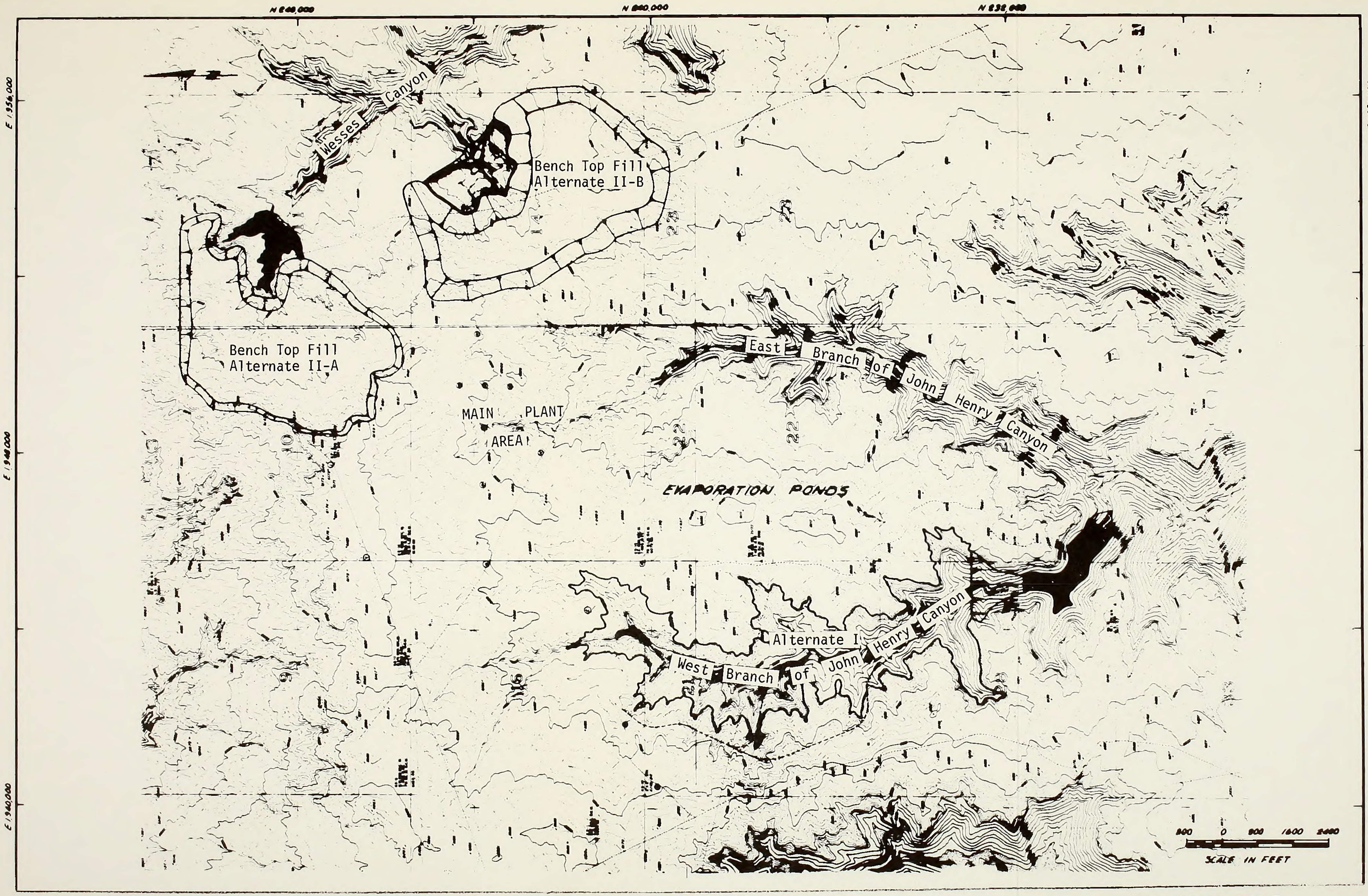

ILLUSTRATION VIII-7
Alternate Ash Disposal Sites - Fourmile Bench

This alternative would require less construction work due to absence of the dam and runoff evaporation pond. However, there are no high bluffs within the proposed plant site boundaries and disposal of this type would create a large mound of waste which would expose more surface area to the climate elements thus increasing the possibility of more rapid erosion and pollution of Warm Creek drainage and Lake Powell. Also it would be more readily visible than an excavated landfill.

Canyon landfill in west branch of John Henry Canyon

This is alternate I in Illustration VIII-7 and would be basically the same operation as bench-top fill. It would consist of placing waste in the west branch of John Henry Canyon, spreading, compacting and covering it with 1 foot of earth, and sloping the waste pile to a runoff collection pond at the downstream end of the canyon. Use of the east branch of John Henry Canyon for a fill site was eliminated due to a greater degree of irregularity in the canyon walls and more difficult access.

In order to retain 450 acre-feet of storm runoff, a pond of the approximate size and location shown in Illustration VIII-7 would need to be constructed with a surface area of 41 acres. An earth dam approximately 200-feet high would be built from dense sandstones excavated in the reservoir area. Material for the core would come from mudstones located in the northern part of the plant site.

In order to construct the dam and fill the canyon, a haul road would be constructed from the power block area to the floor of the canyon. Earthwork for this road would require approximately 269,000 cubic yards of cut and 114,000 cubic yards of fill. Majority of the work would be cutting, which would entail a large amount of blasting. Exact amount is not yet known due to lack of subsurface exploration. However, blasting would be estimated to be between 25 and 50 percent above the 6,000-foot elevation and almost 100 percent below that elevation.

From the power block area to the floor of the canyon, the road would be surfaced with a road-mix asphalt material. Spur roads running over the fill would be treated with a cementing agent. The haul road would support 69-ton dump trucks at speeds up to 50 miles per hour. Maximum grade no greater than 10 percent would occur in the run down the canyon walls.

It might be feasible to surface the haul road with ash which, if compacted properly, could attain high-bearing capacity. This would be determined prior to final design of haul roads and would become practical only after the plant was in operation and producing ash.

Access into the canyon would require additional construction and blasting, with possible damage to the geologic formation. This alternative would result in burial of all natural features of the canyon in an area 2 miles long and 1/2 mile wide. This method of landfill would not be as visible from the surrounding area as the other bench-top landfill alternatives. The depth of the landfill is not known at this time.

Diversion of the runoff from the plateau would be necessary to prevent erosion problems over the ash. Diversion ditches would have to be cut around the canyon fill area, and the water directed into lower parts of the canyon. This disruption of natural drainage flow would disturb approximately 10 more acres of vegetation and increase sediment to flow into Lake Powell by 0.01 acre-foot per year. To attain surface area required for evaporation of storm runoff from the disposal area, a large area of the canyon would be required. Also the probability of revegetation would be less than 3 years out of 10 due to shallow soils and rocky material.

Alternative to landfill - coal mine disposal

An alternative to landfill disposal would be injection of the ash into the coal mine. This would be accomplished by slurrying the ash and pumping it through pipe lines to mine injection points. The ash would be introduced into

mine settling ponds through bore holes, dewatered, and allowed to set up as structural fill in excavated portions of the mine.

This alternative would require approximately 675 acre-feet of additional water per year to produce the slurry necessary for transport to the mine; this would be an increase of 1.5 percent over present water use estimates.

The possibility of ground water contamination by trace elements and other compounds such as sulfates, sulfites and phosphates would become greater as water from slurried ash infiltrates through rock strata in the mine. Also, space would not be available in the mine for at least 10 years and some method of landfill would be needed during this time.

Based on present information it is impossible to predict when, where and if these pollutants would reappear in springs or other surface waters. Also if the pollutants do appear it is not known what the adverse effects would be on wildlife, livestock, aquatic life in Lake Powell, and man. This alternative would reduce the possibility of subsidence in those portions of the mine in which it would be used.

Water supply system

Romana Mesa alternative

An alternate to the proposed tunnel/shaft intake at Warm Creek would be a site on Romana Mesa near Alstrom Point next to the mainstream of the Colorado River (see Illustration VIII-8). At this location, four slanted shafts would be drilled and pumps installed as shown in Illustration VIII-9. The pumps would discharge into a series of booster pumps similar to the system at Warm Creek. Because steep cliffs block inland access, personnel and equipment access to this site would be by boat/barge from the south side of the lake.

The aboveground building would be similar to that for Warm Creek and placed over the drilled shafts. The drilling would not disturb any more area than the building would occupy.

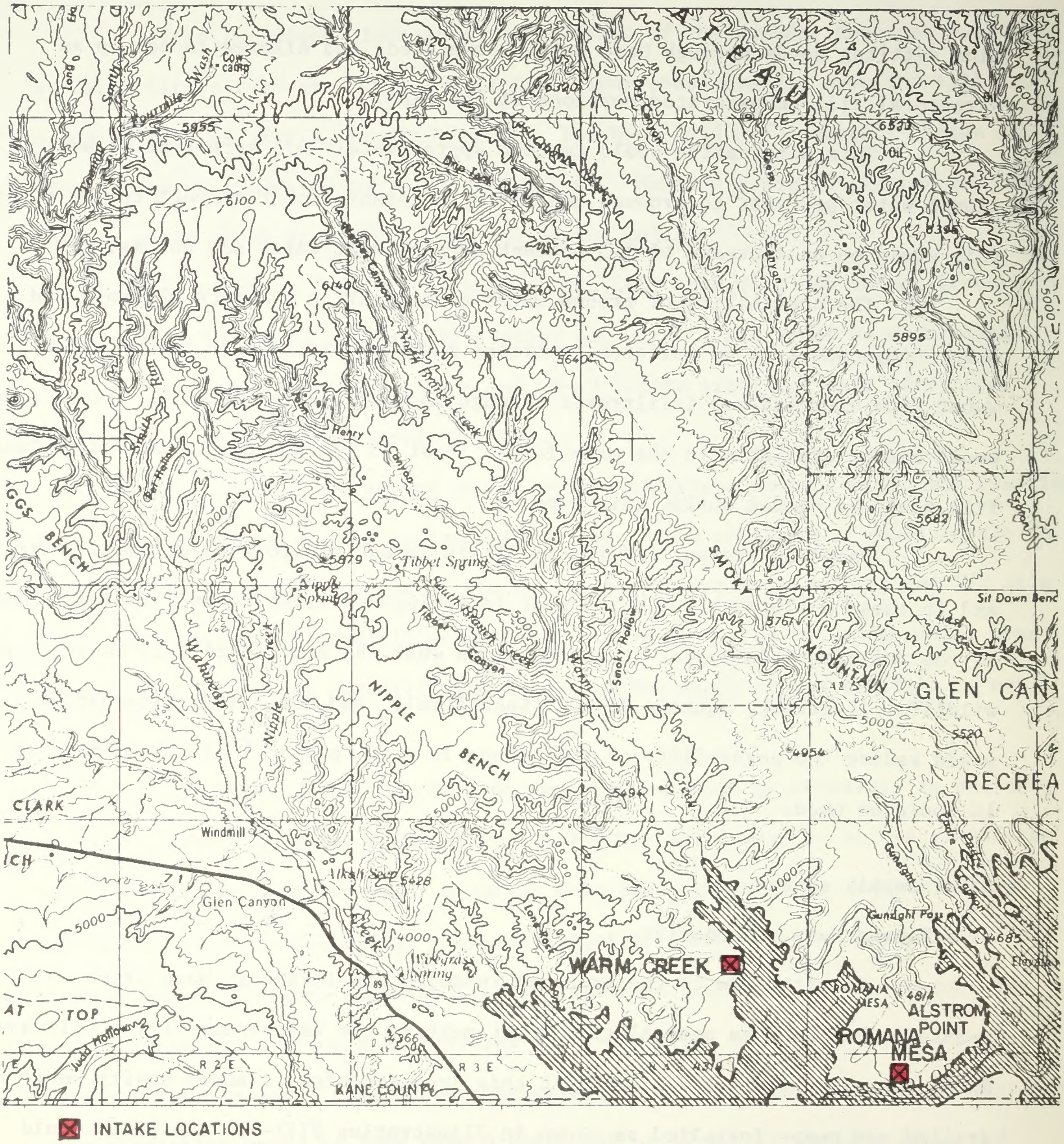

ILLUSTRATION VIII-8

Alternate Intake Locations

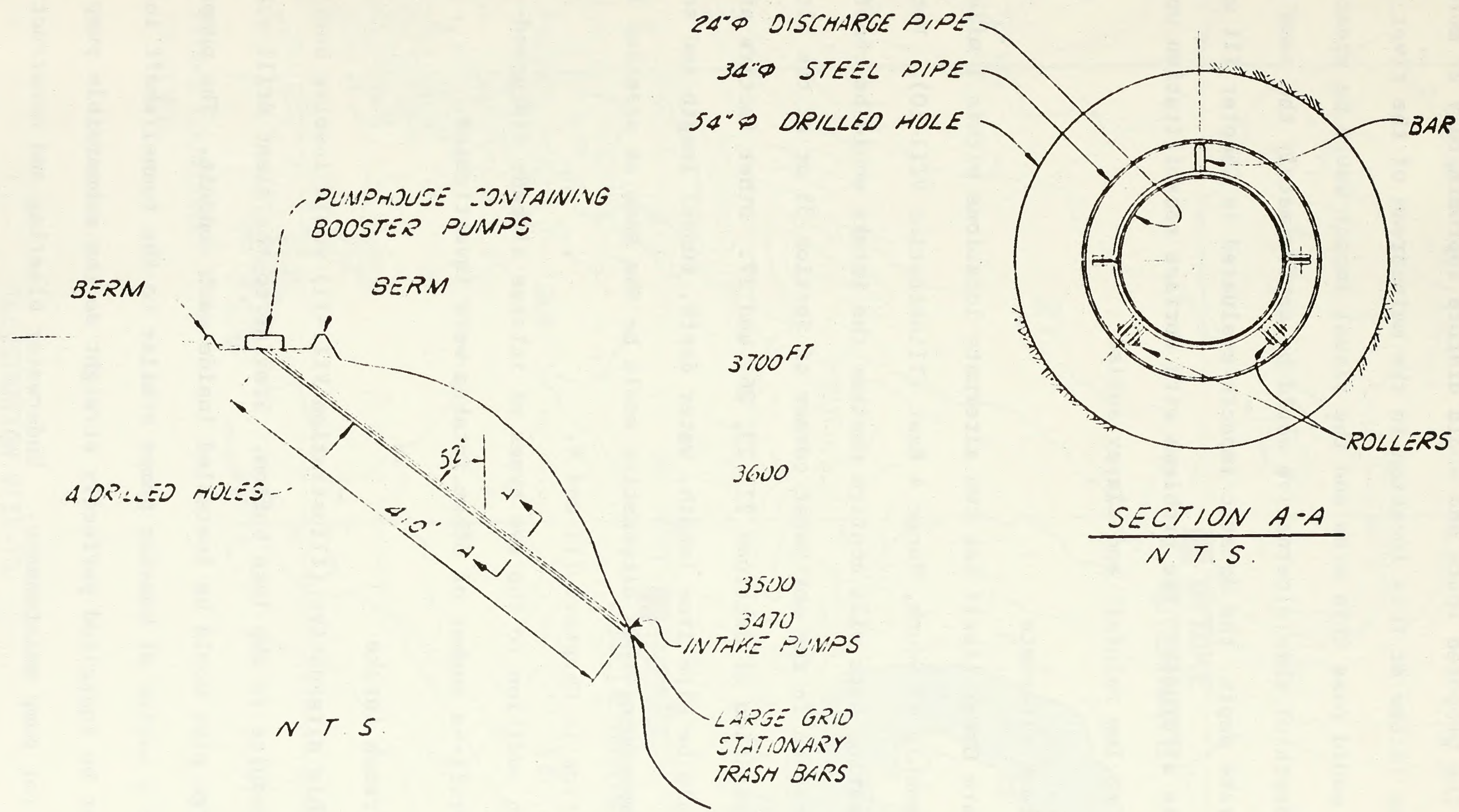

ILLUSTRATION VIII-9

Slant-Drilled Intake - Romana Mesa

The pipe line route from this intake would be approximately 10 miles longer than the proposed route and would disturb approximately 27 more acres. With the pump intake at this location in the mainstream of the river channel, more people would pass this area and the visual impact would be greater. Since the intake depth of this alternative would be approximately the same as the proposed intake depth, the aquatic impacts evaluated in Chapter III would be the same for this alternate. The problems with surface rehabilitation would become greater due to low rainfall and clayey soils.

Warm Creek alternate

Warm Creek itself has two alternate locations within 1 mile of each other in Township 43 South, Range 4 East (Illustration VIII-10). Future geotechnical engineering data will confirm whether the intake would be constructed at the proposed location in the northwest corner of Section 35 or at the alternate site at the intersection of Sections 22, 23, 26, and 27. Other factors affecting the decision would be pipe line length, water depth, tunnel length and soil conditions.

Impacts of this alternative would be the same as assessed for the proposed action in Chapters III and V.

In addition to the two types of intakes already discussed--tunnel/shaft and slant drill--a number of other intakes were investigated.

Trench intake

This alternative (Illustration VIII-11) would involve burying four straight conduits in the lake bottom. Similar to the slant drill scheme, a pump and discharge pipe would be installed inside each conduit. The pumps would discharge into a series of booster pumps similar to the tunnel/shaft intake. The conduit must be installed perfectly straight so the submersible pump can be pulled through it for pump maintenance. Underwater blasting and construction would be difficult and disruptive to natural lake conditions during the construction period.

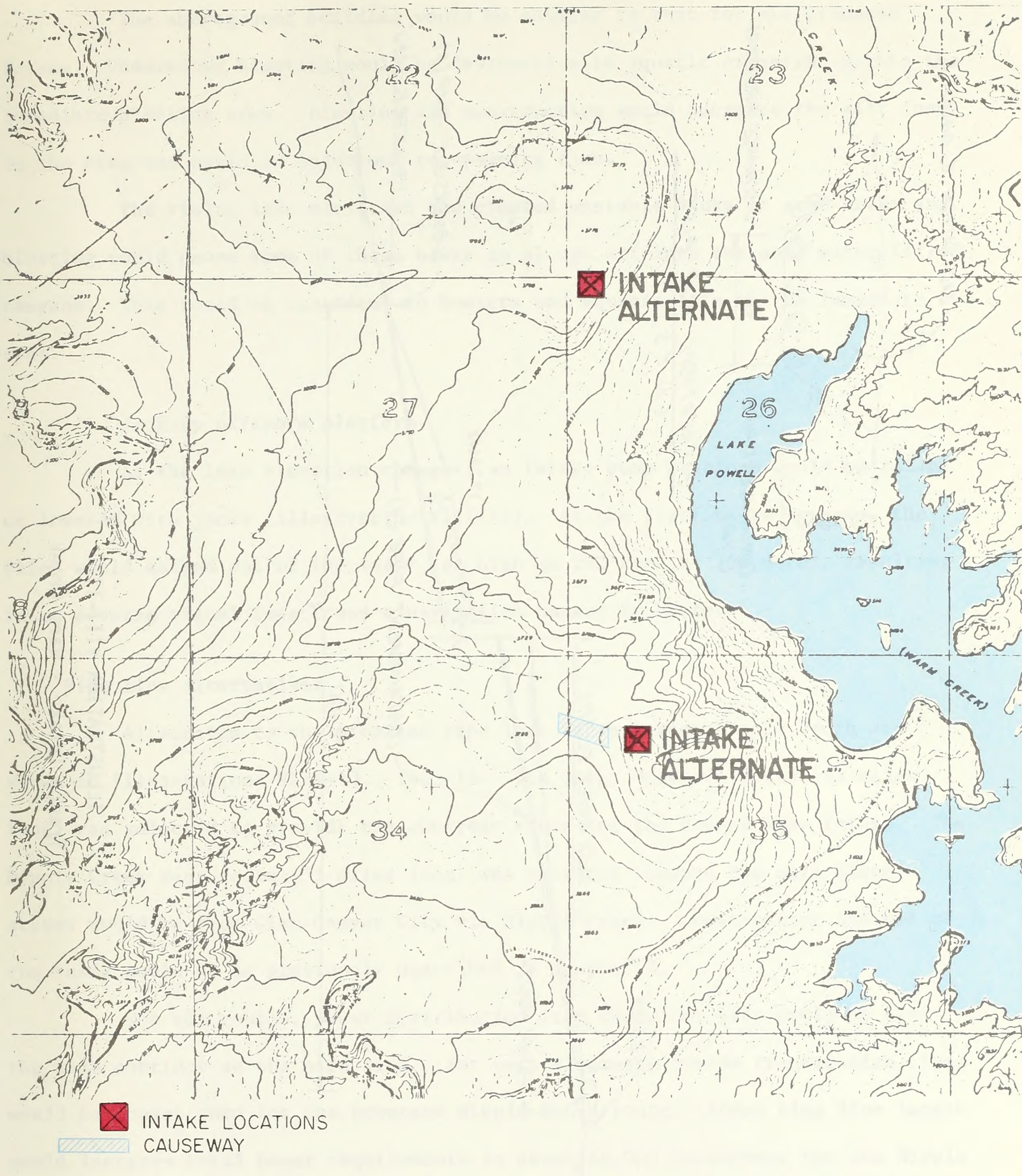

ILLUSTRATION VIII-10

Warm Creek Intake Locations

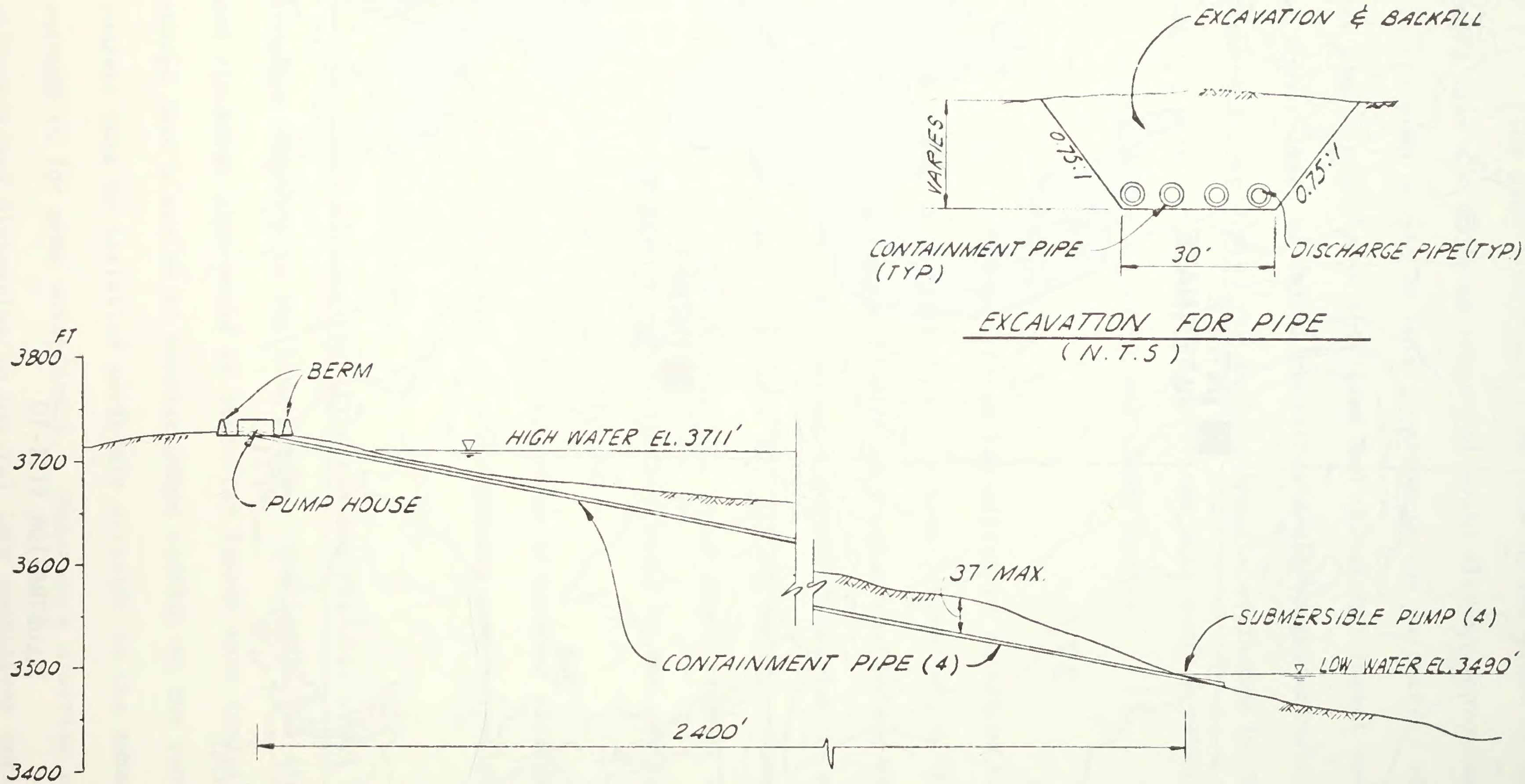

ILLUSTRATION VIII-11
Trench Intake - Warm Creek

The aboveground building would be similar to that for the proposed intake. Underwater blasting would be destructive to aquatic organisms within the immediate blasting area. Blasting and construction would increase the silt load in the area and could be injurious to spawning fish.

The rising lake elevation has created unstable banks in some areas and blasting could cause some of these banks to slough off into the deep water-filled canyons. This could be hazardous to boaters and aquatic life in the immediate area.

Jack-up offshore platform

As the lake elevation changes, an intake pump platform would be raised or lowered with jacks (Illustration VIII-12). As the platform is lowered, the piles would extend out of the water, as high as 250 feet at low water, resulting in an adverse visual impact and a navigation hazard to boaters.

Pipe line alternatives

Alternates to the proposed pipe line route across Nipple Bench are shown in Illustrations VIII-13, -14, -15. The Smoky Mountain route (41 miles long) was selected to provide the shortest route for the Romana Mesa intake. The Nipple Creek West route (35 miles long) was selected because the main plant access would be from Glen Canyon City via Nipple Creek. Construction and use of the roads would be as previously described in Chapter I.

For all routes, power distribution from the plant site would be over the same corridor as the pipe line. For both alternate routes transmission lines would be longer than for the proposed Nipple Bench route. Added pipe line length would increase total power requirements to about 41,000 horsepower for the Nipple Creek route and 47,000 horsepower for the Smoky Mountain route, as compared to 39,000 for the proposed route.

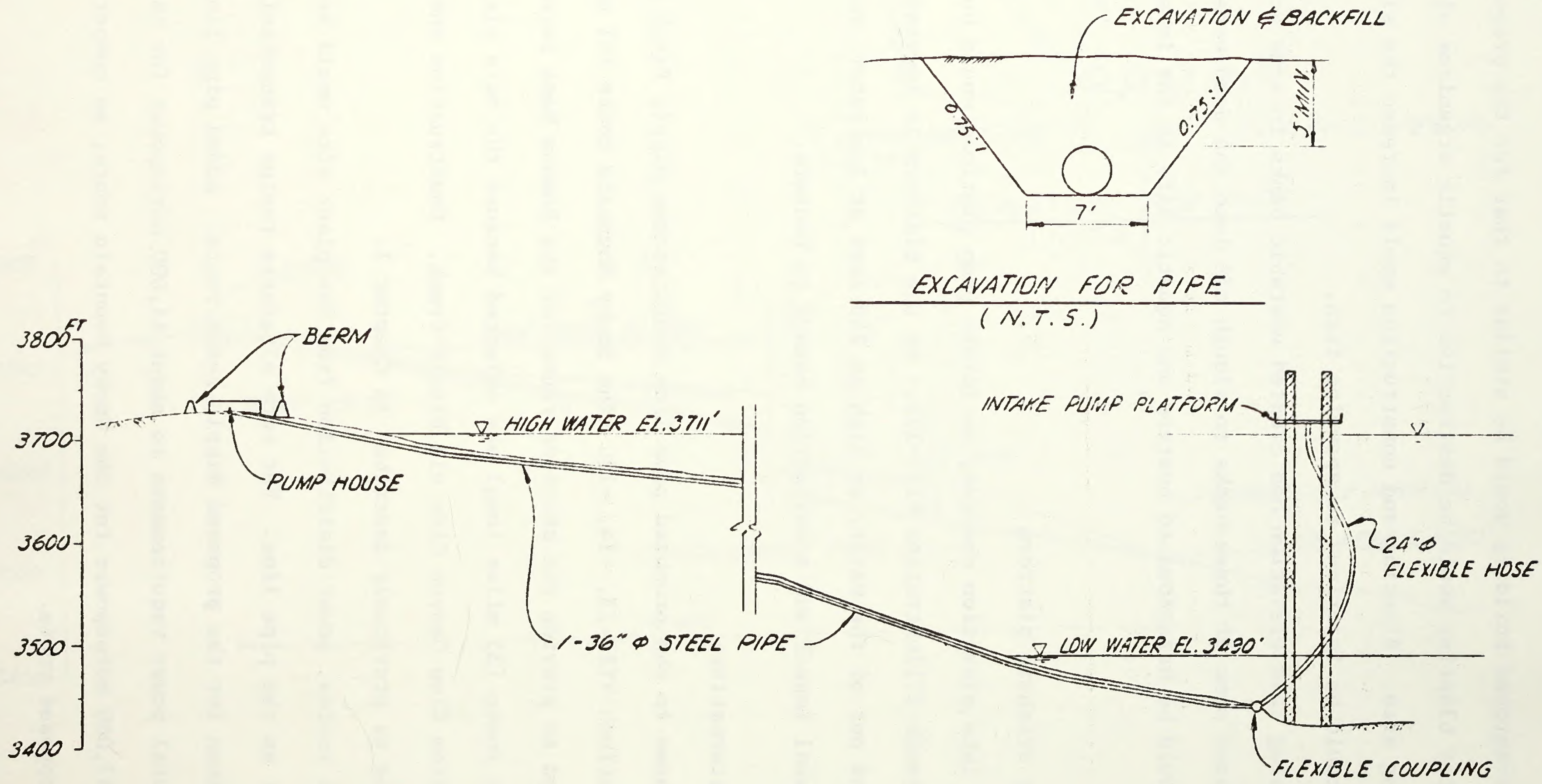

ILLUSTRATION VIII-12

Jack-Up Off Shore Platform - Warm Creek

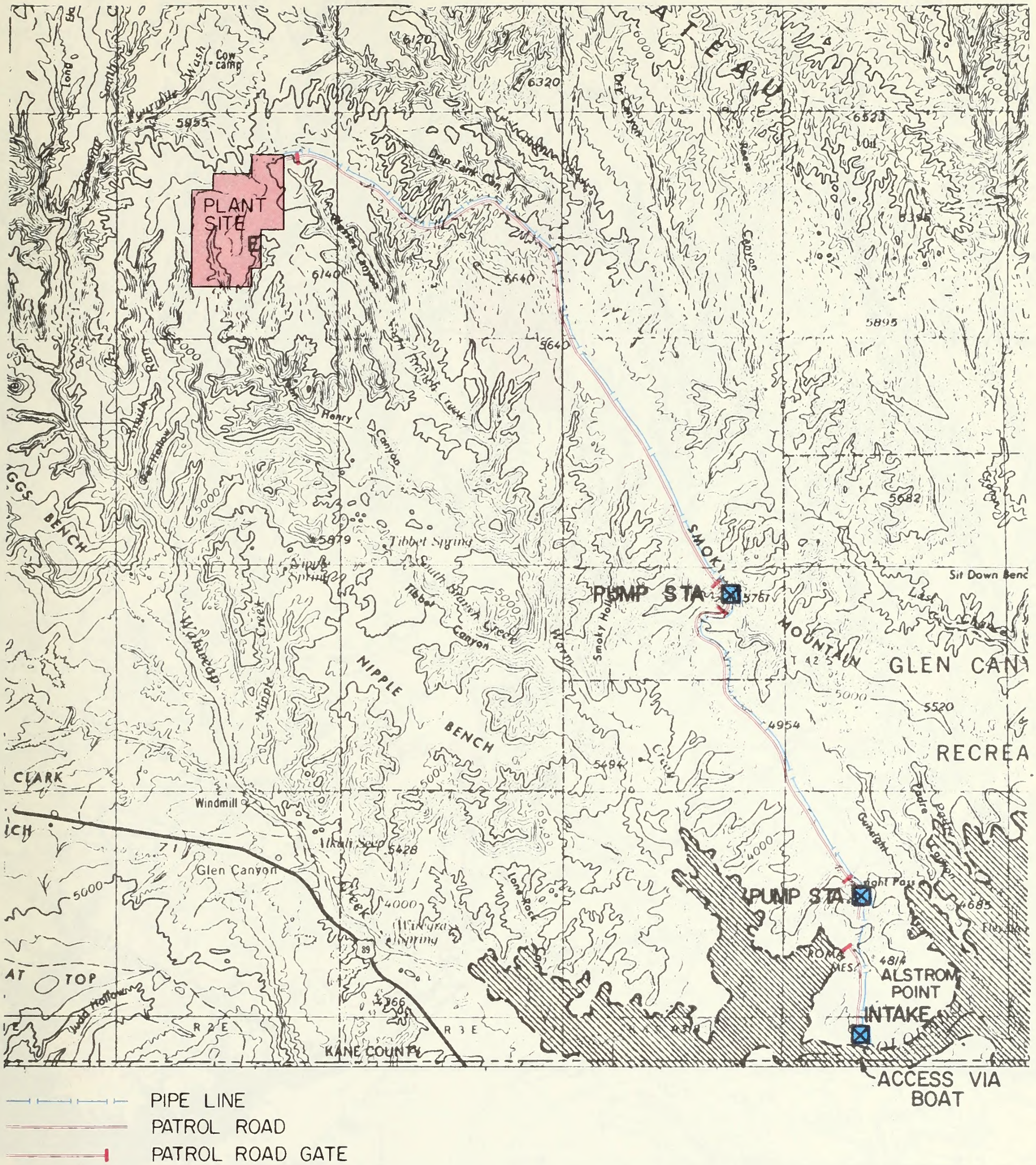

ILLUSTRATION VIII-13

Smoky Mountain Route
Rowana Mesa Intake - Fourmile Bench

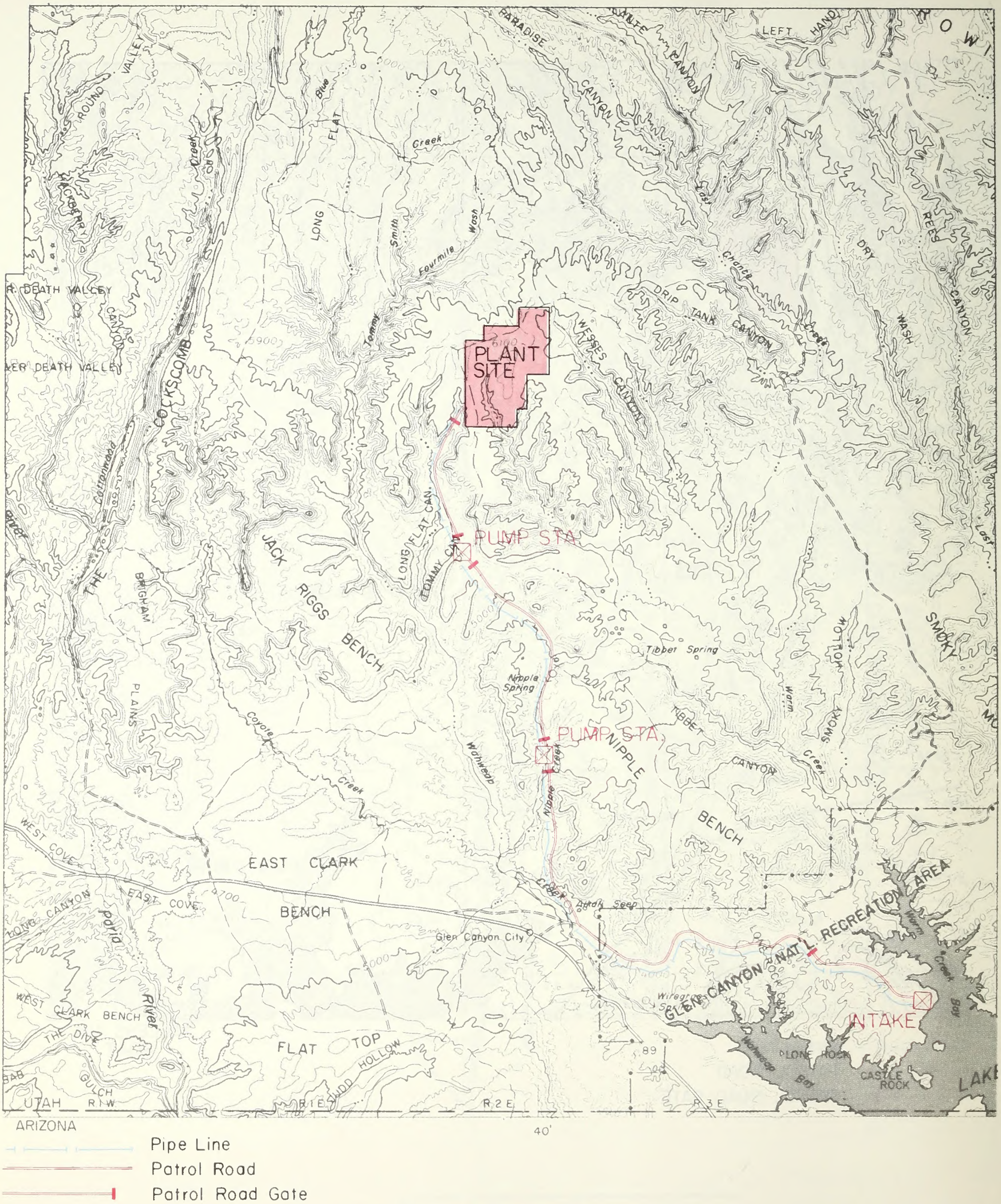

ILLUSTRATION VIII-14

Nipple Creek West Route
Warm Creek Intake - Fourmile Bench

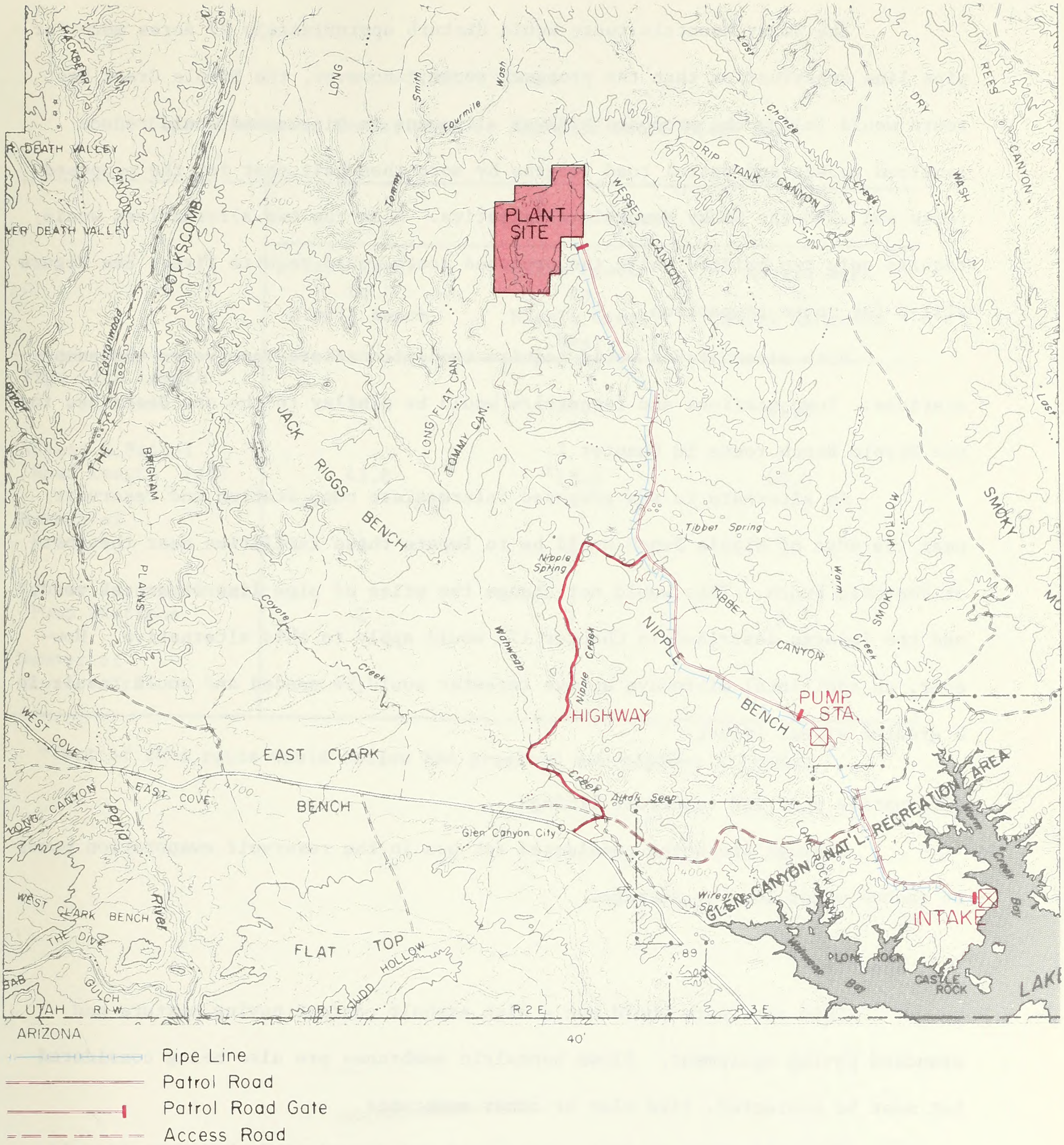

ILLUSTRATION VIII-15

Nipple Bench Route
Warm Creek Intake - Fourmile Bench

The Smoky Mountain route would disturb approximately 27 acres more for pipe line construction than the proposed route. However, the Nipple Creek West route would follow the proposed highway alignment in places and would reduce required access and patrol road lengths by more than half that for the proposed route and also the Smoky Mountain alternative. Also the two alternatives would require only two bridges while the proposed route would require five. See Figure VIII-6 for route comparison.

Both alternatives would require two intermediate reservoirs and pump stations. Pump stations and reservoirs would be similar to the one described for the Nipple Bench route in Chapter I.

An alternate to the proposed intermediate pump station and reservoir near the edge of Nipple Bench would be to locate these facilities near the foot of Fourmile Bench. This would not change the miles of pipe line or access road, and the impacts described in Chapter III would apply to this alternative. However, an additional microwave active repeater would be needed and would result in a greater visual impact.

Alternative pond and reservoir linings

Linings are being considered for use in the reservoir evaporation ponds to reduce water loss by seepage.

Asphalt

This alternate would use a high asphalt content paving mixture and standard paving equipment. Blown asphaltic membranes are also being considered but must be protected, like clay or other membranes.

This alternate would increase sand and gravel needs by approximately 26,000 cubic yards. The seepage rate would be less than that of the proposed lining which is 0.05 inches per year. However, asphalt linings are prone to cracking and would possibly result in higher seepage losses and pollution of ground water in the long run.

FIGURE VIII-8

Pipe Line Route Comparison for Fourmile Bench Plant Site

	Pipe Line Route		
	Warm Creek to Nipple Bench	Warm Creek to Nipple Creek West	Romana Mesa to Smoky Mountain
Pipe Line Length (mi)	30.0	35.0	41.0
Access & Patrol Road Length (mi)	43.8	[a]13.3	40.4
Number of Bridges	5	2	2
Number Intermediate Pump Stations	2	2	2
Number of Reservoirs	1	2	2

[a]Part of this route would follow the proposed new highway alignment.

Commercial membranes

Various chemical manufacturers have developed membranes which are commercially sold as pond liners. These materials include polyethylene, polyvinylchloride, hypalon, butyl rubber and several others. Due to petroleum shortages, some of these may not be available. A protective soil cover would be placed over the membrane. These membranes have a lower seepage rate than the proposed mudstone lining; however, they are easily punctured and could result in a higher seepage rate.

Soil cement

A mixture of natural soils with Portland cement has been used on several projects for lining. This alternative, however, would be highly susceptible to cracking due to the rigidity of the material. If the lining cracked, seep losses would occur and pollution of ground water would be possible.

Cooling system alternatives

Cooling ponds

Cooling ponds are open bodies of water to which heated water is added at one end and from which cooled water is removed at the other. The ponds use the natural heat exchange processes of evaporation, radiation, and conduction-convection to dissipate the waste-heat load from the power plant.

Cooling ponds can serve as a settling basin, operating for extended periods without make-up water if necessary. Ponds do not produce the "drift" (water droplets or mist) that cooling towers do; hence they avoid the resultant environmental effects of drift on soil and vegetation. Unless water quality is very poor, the edges of cooling ponds often become excellent habitat for small animals, and the ponds often provide temporary stopover points for migrating waterfowl. Cooling ponds are generally shallow; however, some can support boating.

Cooling ponds require large land areas - about 6,000 acres for a 3,000 MW power plant. Terrestrial biota would be displaced or eliminated over at least that much area. Water consumption would be increased some 16,500 acre-feet per year over the water requirements of cooling towers, through normal evaporation over the large surface of the pond. Cooling ponds often produce fog at ground level in cool weather, whereas fog produced from cooling towers is discharged aloft. Icing can occur downwind from either a cooling pond or tower.

Cooling ponds in alluvial soils would require liners similar to those applied to evaporation ponds to prevent seepage and water loss.

Spray ponds

Nozzles are used in spray ponds to blow water in fine sprays into the ambient air, and are somewhat dependent on wind speed for best operation. Such a system can reduce the needed pond area substantially; however, pumping costs and water lost in operation must be considered. In addition to evaporation, spray ponds produce drift, depending on wind speed and direction. But, since the spray is released 6 to 8 feet above the surface, the effect of the drift is confined to nearby areas. Fogging and icing can occur in cold weather.

Spray ponds, to meet heat-rejection requirements, would need to contain approximately 360 spray modules of about 75 horsepower each, consuming 20 MW of electricity per year. About 100 acres of land would be required for a spray canal approximately 28,800 feet long, 150 feet wide, and 10 feet deep. Spray ponds designed comparable to that of wet cooling towers would have about the same auxiliary power requirements.

Wet-dry cooling towers

A mechanical draft wet-dry cooling tower includes a dry section with a conventional wet tower. Wet-dry cooling towers have been used with plants where water conservation was an overriding criterion.

The two basic types of mechanical draft wet-dry cooling towers available are the "series flow" and the "parallel path". The series flow tower has a dry section that either precedes or follows the wet section of the tower. In the parallel path wet-dry tower, ambient air travels in parallel streams through a dry surface exchanger and an evaporative section. The streams mix after leaving their respective sections. This mixing reduces relative humidity or moisture content of the tower effluent and consequently reduces, or eliminates, the formation of plumes.

The two basic types of towers may be further divided into plume-abatement and water-conservation designs. The only difference between the designs is the ratio of dry section to wet section. The plume-abatement tower has a dry-to-wet ratio of approximately 0.4:1. The water conservation tower would have a dry-to-wet ratio of approximately 2.45:1.

As dry section cooling is inherently less efficient than wet section cooling, fan power and pumping power must be increased 20 to 30 percent, depending on design.

A wet-dry water-conservation cooling tower designed for winter use would cost 6 times as much as a comparable wet cooling tower. No reliability data is available at this time on wet-dry towers, due to an extremely short period of actual use. According to participants, there are only two wet-dry, plume-abatement cooling towers in operation in the United States, and no water conservation cooling towers. One 14 cell wet-dry cooling tower for a 500 MW unit has been in operation less than a year, and a small, 3-cell wet-dry cooling tower built for a chemical plant has been in operation just over a year. The dry section of a wet-dry cooling tower is most efficient in cool weather, reaching its maximum efficiency just as the water inside it is about to freeze.

The water saving of a wet-dry plume-abatement cooling tower would be rather small, estimated to be between 5 and 10 percent of the total water requirement

for a comparable wet cooling tower. This would be an annual saving of from 2,225 to 4,450 acre-feet of water. Water saving of a wet-dry cooling water-conservation cooling tower would be significant, estimated to be about 60 percent of the total water requirement for a comparable wet cooling tower.

Water consumption of a wet-dry tower would vary considerably, depending on design (i.e., percent dry versus percent wet), operation and meteorology. Fogging and icing could also be controlled by design and operation. Salt accumulation from drift losses would be reduced. Limited experience with this system results in a lack of information regarding its reliability, maintainability and other operating characteristics. All other impacts on the environment, except salt drift from wet-dry cooling towers, would be the same as those described in Chapter III. The salt drift, however, would be considerably lower.

Dry cooling towers

Dry cooling towers use air as the cooling medium to release heat from the power plant to the atmosphere.

Turbine-cycle thermal efficiency, using dry cooling towers, is estimated to be lower by 4 to 10 percent than a conventionally cooled turbine cycle. Thus a dry cooling tower plant would require up to 10 percent more fuel, or an additional 900,000 tons of coal annually. It would also release up to 18 percent more heat to the surroundings, compared to a conventionally cooled (wet cooling tower) power plant.

For a dry cooling tower application, the turbine must be capable of operating at higher peak back pressures, approximately 10 to 14 inches of mercury absolute (in Hg Abs), and at a much wider variation of back pressures. Turbines now designed for conventionally cooled (wet cooling tower) plants -- operating between slightly less than 1.0 in Hg Abs and 4.0 in Hg Abs with a maximum design back pressure of 5.0 in Hg Abs -- would not be suitable for the severe performance

requirements of dry cooling tower plants. Turbine generators suitable for the high back pressure required by a dry cooling tower plant are not in production.

Dry cooling towers work most efficiently in cold weather. However, the large exposed heat-transfer surfaces of a dry cooling tower are susceptible to rapid cooling and the possibility of freezing condensate inside the finned tubes during cold weather. The result would be reduced load operation or an accidental loss of load. With direct contact condensers and condensate circulating through the towers, no antifreeze substance may be used. A startup in freezing weather would be a difficult task. Information available does not provide a solid basis to assess lifetime reliability, maintainability and other operating characteristics of this equipment.

Water consumption in a dry cooling system would be essentially zero. Dry cooling would eliminate problems of fogging, icing, drift and blowdown. There is controversy over what the environmental impact might be from large quantities of warm air discharged into the atmosphere. The potential for modification of local meteorology, such as the formation of cumulus clouds, requires further study.

There is an increased noise problem with dry cooling tower, due to the forced air systems used. Dry cooling towers would not disturb or be detrimental to soil, vegetation and wildlife any more than would wet cooling towers; and there would be no salt drift detrimental to vegetation and soils.

The Energy Research and Development Agency (ERDA) has established a test program to determine the feasibility of dry and wet-dry cooling tower applications in the United States. The program is being developed by Battelle Laboratories for ERDA under Contract No. E (45-1): 1830. They plan a long-term testing facility at the expanding 330 MW Wyodak station in Wyoming. The test program is expected to continue for several years. They will study the design and operating problems of various cooling tower types, materials of design and construction, economics,

maintenance and factors prior to establishing appropriate codes and standards for manufacturing and installation. The ERDA program anticipates that results from the Wyodak program will not be known until 1982 at the earliest.

Administration building, shop and warehouse facilities

According to the participants, alternative administration, shop and warehouse facilities would not be significantly different from those proposed. Impacts would be the same as discussed in Chapter III.

Access roads

Although minor changes might be made in alignment during final design, basic area and mileage of on-site roads would remain approximately as projected in the proposed action. Impacts would be the same as discussed in Chapter III.

Fuel oil system

One alternative to fuel oil would be natural gas. Similar coal-burning plants within the Edison system use natural gas for main boiler ignition systems and auxiliary boiler steam generation. However, in recent years availability of natural gas has substantially decreased, and future projections indicate an almost total absence of gas for the generation of electricity.

Another alternative fuel would be propane. Disadvantages include a potentially limited supply of propane, and the sheer quantity necessary. Approximately 27,000 tons per year, or a total of 810,000 tons, would be required for normal plant operation from 1985 to 2015.

Lime/limestone supply and handling alternatives

Limestone from the proposed quarry would not be directly suitable for use in scrubbers, at the power plant, or for rock dusting in the underground coal mines. It would have to be processed. Seven alternative limestone processing and handling systems were considered by the participants:

(1) Processing at plant site for generating plant needs, and at the coal mine for mine needs; lime used for SO_2 removal.

(2) All processing at quarry site; lime used for SO_2 removal.

(3) Purchasing from outside supplier; lime used for SO_2 removal.

(4) All processing at plant site; limestone used for SO_2 removal.

(5) Processing at plant site for generating plant needs, and at coal mine for coal mine needs; limestone used for SO_2 removal.

(6) All processing at quarry site; limestone used for SO_2 removal.

(7) Purchasing from outside supplier; limestone used for SO_2 removal.

A summary of the criteria used to evaluate these alternatives and the proposed action is presented in Figure VIII-9. Lime for water pretreatment would be purchased from outside suppliers for those alternatives using limestone for SO_2 removal.

Alternative 1: Processing at plant site using lime

Processing and handling limestone at the quarry for alternative 1 is the same as described in the "Limestone Quarry" description, Chapter I. Crude limestone would be hauled to the plant site for conversion to lime for use in SO_2 removal and water pretreatment.

The lime/limestone handling system on the plant site for alternative 1 would be similar to the proposed action. Amounts of limestone needed and lime produced are the same. The difference between alternative 1 and the proposal is that the limestone waste stream (particles less than 0.25 inch) from the lime-processing system would not be processed at the plant site. This limestone would be hauled to the coal mine for further processing.

Approximately the same amount of limestone and the same number of trucks would be used as in the proposed action. The limestone would then be crushed and ground at the mine, with related screening operations, to produce rock dusting

FIGURE VIII-9

Kaiparowits Project Limestone Alternatives for Johns Valley Site
(Estimated quarry quantities and requirements)

	Proposed Action Chapter I	Alternative						
		1	2	3	4	5	6	7
Major Construction								
Access road	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Miles	22	22	22	--	22	22	22	--
Surface road	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Miles	40	40	40	--	40	40	40	--
Shop/office	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Quarry road	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Miles	2	2	2	--	2	2	2	--
Water supply	Small	Small	Small	None	Small	Small	Small	None
gallons per minute	1.5	1.5	5.0	--	1.5	1.5	5.0	--
Transmission power line	No	No	Yes	No	No	No	Yes	No
Miles	--	--	31	--	--	--	31	--

(continued)

FIGURE VIII-9 (continued)

	Proposed Action Chapter I	Alternative						
		1	2	3	4	5	6	7
<u>Major Construction</u> (Continued)								
Crushing and grinding facilities	One	Two	One	None	One	Two	One	None
Kiln	Yes	Yes	Yes	No	No	No	No	No
Covered storage at quarry	No	No	Yes[a]	No	No	No	Yes	No
<u>Highway Traffic Density</u>[b]								
Limestone	30	30	8	--	30	30	30	30
Lime	--	--	13	13	½	½	½	½
Coal	--	--	6[c]	--	--	--	--	--
Estimated employee trips	21	23	19	--	18	19	18	--
<u>Estimated Employees Required</u>								
Total	60	65	55	--	55	58	55	--

(continued)

FIGURE VIII-9 (concluded)

	Proposed Action, Chapter I	Alternative 1	2	3	4	5	6	7
<u>Surface Disturbance</u> (Acres)								
Highway surfacing (existing unimproved roads)	80	80	80	--	80	80	80	--
Shop/office	5	5	5	--	5	5	5	--
Quarry	131	131	131	--	131	131	131	--
Quarry access road	18	18	18	--	18	18	18	--
Magazines	3	3	3	--	3	3	3	--
Limestone stockpile	3	3	4	--	3	3	4	--
Crushing and grinding	--	--	2	--	--	--	2	--
Kiln	--	--	2	--	--	--	--	--
Transmission line	--	--	18	--	--	--	18	--
Covered storage (limestone, lime, and coal)	--	--	1	--	--	--	1	--
Total	240	240	264	--	240	240	262	--

a Coal, lime and rock dust
b Trips per day on six-day basis and 25-ton payload
c Return

material at 100 percent minus 20 mesh and a minimum of 70 percent minus 200 mesh. This material would be retained in an enclosed storage area until needed at mine portals.

Alternative 1 would concentrate facilities within complex sites where basic operations are scheduled on a 24-hour-a-day basis. This alternative would require increased manpower to operate two small crushing plants. The impacts of this alternative would be the same as those discussed in Chapter III.

Alternative 2: Processing at quarry site using lime

Alternative 2 concerns construction of the same processing facility proposed at the power plant, but located instead at the quarry site. The site at the quarry would be adjacent to the shop-office and limestone stockpile areas, immediately to the side of the main quarry access road. Crushing and grinding facilities, the kiln and its baghouse equipment, and the enclosed stockpiles for various fuels and products would be constructed in Johns Valley, Utah. An electrical transmission line of approximately 15 miles would have to be constructed to the Johns Valley site. Process facilities would require approximately 4 additional acres.

This facility would be used on a 7-day week basis, to convert 350 tons of crude limestone a day into 175 tons of lime, to be used at the generating station for SO_2 removal and water pretreatment. Lime would be hauled to the generating station in enclosed trailers 6 days a week. An additional 290 tons of pulverized limestone a day would be produced 5 days a week for rock dusting at the mine. This would be hauled to the mine 6 days a week, in enclosed trailers. Approximately 7 trucks a day, on the return trip from the generating station, would haul a total of 175 tons of pulverized coal to fire the rotary kiln; this is 125 tons a day more than in the proposal.

Lime delivered from the quarry site would be unloaded pneumatically from trucks into a storage bin at the plant site. The lime would then be handled

as described in the "Limestone/Lime Supply and Handling" discussion in the plant description section of Chapter I. Truck-loading facilities would be constructed at the plant site to load coal needed at the quarry to fire the kiln. Dust suppression systems would be provided at the truck loading facility.

Pulverized limestone for rock dusting, delivered from the quarry site, would be handled at the mine in the manner described in the "Coal Mine" description in Chapter I.

This alternative would result in a reduction in highway transportation required for hauling lime material rather than limestone to the power plant site. Approximately eight fewer trips a day (48 a week) would be required.

This alternative would require construction of a larger water system to supply an additional 116 acre-feet of water annually to support calcining at the quarry site. Water is in short supply in the limestone quarry area, as all water rights are now appropriated. Surface disturbance from constructing the power line and kiln facilities would affect about 22 acres. Such surface disturbance would reduce vegetation necessary to support one deer a year wintering in the area prior to rehabilitation.

Alternative 3: Purchasing from outside suppliers using lime

Since lime would be purchased from an outside supplier, no processing equipment would be needed and no facilities would be needed for transporting coal to the kiln. Facilities and amounts of lime handled on the plant site would be the same as in alternative 2.

The handling of pulverized limestone for rock dusting at the mine would be the same as described under "Coal Mine Description", Chapter I.

The 240 acres of quarry in Johns Valley would not be disturbed or occupied by man-made facilities. This would allow at least ten deer to continue wintering in the area.

All known outside lime and limestone suppliers are at a much greater distance from the plant site and mine than is the proposed quarry. Thus, the increased truck-railroad haul would use more energy to supply lime and limestone. Haul distances are not known at this time.

Alternative 4: All processing at the plant site using limestone

The processing and handling of limestone at the quarry for alternative 4 would be the same as described in "Limestone Quarry," Chapter I. All processing and handling would be at the plant site, as described in "Limestone/Lime Supply and Handling" in the plant description section of Chapter I. However, instead of lime being used in the SO_2 removal system, limestone would be used and the kiln would not be required. Approximately the same amount of limestone would be needed for this alternative. Lime would still be needed for water pretreatment and would be purchased from an outside supplier.

Processing and handling of limestone at the coal mine for alternative 4 would be the same as described in "Coal Mine," Chapter I.

With this alternative all limestone-processing facilities would be at the plant site where power, water and other facilities would be readily available. Coal consumption would be reduced by 70 tons a day, or 894,250 tons during the life of the project. All other impacts would be the same as discussed in Chapter III.

Alternative 5: Processing at plant site for plant needs and at coal site for mine needs using limestone

Processing and handling of limestone at the quarry for alternative 5 would be the same as described in "Limestone Quarry," Chapter I.

Alternative 5 is the same as alternative 4 except that the limestone needed for the coal mine would be processed there instead of at the plant site. Lime needed for the water pretreatment system would be purchased from an outside supplier.

Alternative 5 would require less handling of limestone at the plant site. The total material handled at the mine and plant would remain the same.

Crude limestone would be delivered to the mine from the quarry. Approximately the same amount of limestone and the same number of trucks would be used as in alternative 4. Limestone would be crushed, ground and screened to produce rock dusting material at 100 percent minus 20 mesh and a minimum of 70 percent minus 200 mesh. This material would be retained in enclosed storage until needed at mine portals.

Alternative 5 would concentrate industrial facilities with complex sites where basic operations are scheduled 24 hours per day. However, inefficiency resulting from the increased manpower required to operate two small crushing plants would result. Impacts resulting from this alternative would be the same as those discussed in Chapter III.

Alternative 6: All processing at quarry site using limestone

Alternative 6 would require construction of the same processing facility as proposed for the power plant in alternative 4, but at the quarry site instead. The facility would be adjacent to the shop-office and limestone stockpile areas, beside the main access road. Crushing and grinding facilities, and enclosed storage for various fuels and products, would be constructed in Johns Valley. An electrical transmission line of approximately 15 miles would have to be constructed to the Johns Valley site. Processing facilities would require approximately 2 additional acres.

This facilitiy would be used 7 days a week to process 350 tons of crude limestone a day for SO_2 removal at the generating station. Limestone would be hauled to the generating station in enclosed trailers 5 days a week. An additonal 290 tons of pulverized limestone a day would be produced 5 days a week for rock dusting in the mine and hauled there in enclosed trailers 6 days a week.

In alternative 6, limestone would be processed at the quarry before being hauled by truck to the plante site, where it would be unloaded into a storage bin. A dust suppression system, using non-toxic chemicals would be provided at the unloading facility. Lime would be purchased from an outside supplier for the water pretreatment system.

Pulverized limestone from the quarry, for rock dusting, would be handled at the coal mine in the same manner as described in "Coal Mine," Chapter I.

Impacts of this alternative would be the same as those described for alternative 2.

Alternative 7: Purchase from outside supplier using limestone

This alternative involves the purchase of limestone for both scrubbing and rock dusting from outside sources, and no action at the proposed quarry would be needed.

Since the limestone would be purchased, no processing equipment would be needed. Facilities and amounts of limestone handled on the plant site would be the same as in alternative 6. Lime needed for the water pretreatment system would also be purchased from an outside supplier.

The handling of pulverized limestone, for rock dusting at the mine, would be the same as described in "Coal Mine," Chapter I.

Known outside suppliers are farther from the mine and power plant than is the quarry, so increased energy and money to transport the lime and limestone would be expended. However, new limestone and lime-processing equipment, and a new quarry, would not be necessary.

Coal mine design

Mining methods

Surface mining methods

Surface mining methods remove overlying strata (overburden), thereby exposing minerals for subsequent recovery. Two surface mining methods, conventional area strip and multiple-bench, open-pit, can be analyzed for use on the Kaiparowits Plateau.

Conventional strip mining can be used where coal occurs in multiple beds, as in the Kaiparowits Plateau; however, current technology limits the method to areas where coal is overlain by no more than about 180 feet of overburden (Cassidy, 1973).

Since most of the Kaiparowits Plateau coal beds are overlain by a minimum of about 400 to 500 feet of overburden, the conventional strip method cannot be used. The best alternative is the multiple-bench, open-pit mining method where flat benches of varying widths and heights are developed to uncover coal (Cummins and Given, 1973). The resulting mine may resemble a large, wide staircase or a gigantic sports arena. As overburden from each bench is removed, coal deposits are uncovered and mined.

This method is most applicable where thicknesses of coal to be mined are relatively large in comparison to the overburden to be removed, where much of the coal is too deeply buried to be uncovered by conventional methods, and where multibed occurrence of coal prevents orderly disposal of waste overburden without excessive rehandling.

Where the method is used to mine multiple beds of coal, such as those found in the Kaiparowits Plateau, coal is actively mined on more than one bench at a time. Consequently, waste material (either overburden or rock between separate coal beds) must be transported away from the active portion of the mine and disposed of either outside the mine or in previously mined-out sections. Depending on mine

design and distances which waste must be hauled, mining can be conducted by power shovels, front-end loaders, or bucket-wheel excavators loading into trucks, trains, or conveyor belts for disposal. As in conventional strip mining, motorized scrapers, in conjunction with bulldozers, may be used to remove topsoil, regrade spoil piles, and excavate softer overburden.

Surface mining affords a much higher overall percentage of coal recovery, upwards of about 90 percent, compared to an overall average of about 50 percent by underground techniques. Much of the coal that could not be recovered by underground methods, because of pronounced irregularities in coal bed thicknesses, too close proximity of multiple beds, "splits" or partings, or unfavorable roof or other geologic conditions, would be available by surface methods.

Extensive drilling programs, conducted by the participants on the prime area of the lease composite, have disclosed an overall average aggregate coal thickness of between 30 and 40 feet. Assuming the medium of 35 feet, each acre would yield about 55,000 tons of coal at 90 percent recovery. Therefore, to provide 420 million tons of raw coal over the 35-year life of the project, a total of 7,636 acres or 12 square miles of the coal-bearing land would be mined.

Coal recovery and required area of excavation are determined as follows:

$$\text{Yield per acre (tons)} = 1740 \frac{\text{tons}}{\text{acre-feet}} \times 35 \text{ feet} \times .90 \text{ (recovery factor)}$$

$$= 55{,}000 \text{ tons per acre}$$

$$\text{Area (square miles)} = 420{,}000{,}000 \text{ tons} \times \frac{1 \text{ acre}}{55{,}000 \text{ tons}} \times \frac{1 \text{ square mile}}{640 \text{ acres}}$$

$$= 12 \text{ square miles}$$

The average depth down to the uppermost coal bed ranges between 400 and 500 feet. Mining down through coal horizons would deepen excavations by

approximately 150 to 200 feet. This would mean that a volume of about 1.5 cubic miles of material would be excavated.

Overburden disposal would initially be a problem as it would not be logical to place material from the first open pit on a surface that was scheduled for subsequent mining. Therefore, the only feasible location for disposal of any volume of initial overburden would be in areas of canyons containing underlying coal deposits. Since multiple open pits would likely be operated simultaneously to provide the daily tonnage requirement of washed coal for the generating station, several canyons would probably be selected as initial waste disposal sites until enough pit areas were mined out to provide locations for backfilling.

The impact on topography would be extensive, involving some 12 square miles as indicated. The entire appearance and shape of the surface would be altered. All existing vegetation and land forms would be obliterated and would never be exactly restored in spite of whatever reclamation measures might be taken. Furthermore, effective rehabilitation would require several years before the area could be restored to a condition comparable to the original state.

The geology of the entire section would be altered by breaking up and relocating over 600 feet of waste strata and by the virtual complete removal of several coal beds aggregating 30 to 40 feet of thickness. Any paleontological resource, such as fossils, petrified wood, or bones would be destroyed. All existing aquifers in excavated areas would also be obliterated.

Disposal of enormous volumes of waste in canyons would create a ready source of pollution to lower drainages during storm runoff.

The aesthetic impact of mining operations would be greatly increased since all activity would be visible from the surface. However, exposure of such a large-scale mining venture could create a positive medium by which the public could gain better insight as to what is entailed in making a common consumer product available.

Noise pollution would be greatly amplified by blasting and operation of various large earth-moving machines and vehicles. In spite of dust suppression techniques, air pollution would be increased by machinery and vehicular movement as well as by winds blowing across the broad exposures of waste material and coal. Wildlife would be disrupted by the activity in and near pit areas.

Surface mining would provide a safer working environment for the mine force than underground methods. Underground mining is statistically more hazardous than surface mining and man-hour exposure to any hazard would be reduced since only about one-fourth as many miners (500) would be involved in surface mining operation.

In situ mining

In situ (in place) mining (more appropriately termed in situ gasification since the coal is not physically mined), is a process in which a portion of the in-place coal is burned to provide heat for destructive distillation of remaining coal. All operations are conducted through drill holes from the surface.

The process involves drilling numerous, closely spaced drill holes; hydraulic fracturing of the coal bed; ignifition of in-place coal; injection of air or pure oxygen to support combustion, create heat, and cause destructive distillation of coal; and capture and processing of resulting gases.

Impacts associated with this type of project would include numerous access roads to the multitutde of drill holes, and associated equipment to draw off gases evolving from burning coal beds. A plant similar to those associated with coking coal at steel mills or an oil refinery would be required nearby to process coal gases and route methane gas (CH_4) as fuel to the generating station. This plant could encompass possibly 1 square mile of land surface.

Although this type of plant would contribute to air pollution (typical of any refinery), and to some possible water pollution by disposal of processing

wastes in the plant, fertilizers and other useful chemicals could be derived from coal gases that would otherwise be lost in normal power generation by direct burning of coal. Additionally, a positive impact would be the elimination of waste ash normally associated with coal-fired generating stations.

At present, the process is experimental. Technology has not been developed to effectively control combustion, assure efficient recovery of the in-place resource, control surface subsidence, or to prevent water and air pollution from gasification of shallowly-buried coal beds.

As with underground mining, in situ gasification would cause subsidence of overlying strata and possible surface degradation. Water-bearing aquifers located above the coal could be ruptured. Water from aquifers could leak into and react with coal being gasified. Such leakage could further complicate a presently difficult process, pollute aquifers located below the coal bed, and pollute surface waters. Also, should subsidence break through to the surface, gas created by distillation and combustion could escape into the atmosphere.

Surface facilities involved with in situ gasification are more complex than those required for underground mining, and less complex than those needed by surface mining. In addition to drill holes to the coal bed, pipe line systems to inject air or oxygen and to gather combustion products, and plants to compress air or extract oxygen from the atmosphere and to purify combustion projects, would be required. The process would also require a large network of closely spaced roads to service the drill holes.

In situ mining would cause more environmental impacts than either surface or underground mining.

Coal transportation methods

Transportation of coal from mine portals to the washery and from washery to power plant could be accomplished by several alternative methods: off-highway trucks, railroads, or slurry pipe line.

Truck haulage

Off-highway trucks with capacities up to 200 tons could be used to provide coal transportation. Truck haulage would require operation of large numbers of trucks, construction of haul roads from mine portals to washery and from washery to power plant, construction of additional maintenance facilities, and employment of additional personnel for drivers.

Impacts caused by truck haulage would be: increased surface disturbance by construction of haul roads and maintenance facilities; increased noise levels due to continuous operation of large trucks; and increased air pollution due to engine emissions, road dust, and coal dust blown from the trucks. Also, coal would be spilled along haul roads, particularly around curves and as a result of accidents.

Coal dust and coal spillage from trucks could be controlled by covering the trucks. Surface disturbance due to construction of haul roads and maintenance facilities could not be mitigated. Air pollution from engine emissions and increased noise levels from truck operation could be partially controlled but not entirely eliminated.

Truck haulage is probably an impractical alternative to belt conveyor transportation. Capital expense of trucks, construction of haul roads and operation of maintenance facilities would probably exceed that required for the proposed conveyor system. Operation, maintenance, and labor costs of truck haulage would probably exceed those of proposed belt conveyors.

Truck haulage would provide more environmental impacts than a conveyor system. Surface disruption due to construction, noise levels inherent in operation, and air pollution due to engine emissions would all be substantially greater if trucks were used instead of belt conveyors.

Railroad

A railroad could be constructed linking mines to washery and washery to power plant. Rail transportation of coal would eliminate all cross-country belt conveyors now proposed by the participants. Due to rugged terrain in the area and shallow gradients traversable by railroad equipment, at least 40 miles of track would have to be constructed to connect all facilities.

Environmental impacts would be increased by surface disturbance from construction of track and maintenance facilities, increased noise levels from train operation, and increased air pollution from engine emissions and coal dust blowing from loaded and empty cars. An accident, either a train wreck or a simple derailment, could cause significant coal spillage.

Coal dust could be controlled by using covered gondola cars. Surface disturbance due to construction could not be mitigated or reduced. Air pollution from engine emissions and increased noise levels from train operation could be partially controlled but not entirely eliminated.

Railroad transportation is probably an impractical alternative to conveyor belt transport. Both capital and operating costs of rail transport would be more expensive than a conveyor belt system but probably less expensive than a truck haulage system.

A railroad haulage system would create approximately equal environmental impacts as truck haulage. However, impacts from rail haulage would be significantly greater than the proposed conveyor system due to additional surface disruption caused by construction, noise levels inherent in operation, and air pollution from engine emissions.

Slurry pipe line

A slurry pipe line for coal transport, although technically feasible, would not be a viable alternative to belt conveyor transportation for the short

distances involved in the proposed project. Slurry pipe lines offer some environmentally desirable advantages for transportation over long distances. However, where distances are short, the required consumption of water and installation of necessary support facilities would override any favorable aspects.

Site arrangement

The participants have proposed sites for all major components of the mining complex, but detailed engineering and environmental analyses may require location changes of some, or all, of the surface facilities. For example, the participants are continuing to explore their coal leases. Should exploration show that significant coal reserves are present in areas not now scheduled for mining, the entire layout of the mine complex could be changed. Single components of the project, such as the washery or the conveyor belts, could be relocated in response to engineering or environmental analyses.

If major redesigning of the project would be necessary, net impact on the environment would depend on whether additional facilities, in excess of those presently proposed, would be required.

Should no additional facilities be required, no additional adverse or favorable environmental impacts are foreseen. Impacts of construction and operation of the mine complex would be essentially equivalent, regardless of the location of surface facilities.

The same conclusion would apply to an attempt to further centralize or decentralize the project components. Total surface area impacted would change only slightly in either case. Further centralization would concentrate impacts into a smaller area but the magnitude of each impact would probably be increased. Decentralization would reduce the magnitude of individual impacts by spreading the impacts over a larger area. The crux of the centralization/decentralization question is whether a number of small impacts spread over a large area is more

desirable than a number of large impacts concentrated into a small area. In either case, the overall impact would be unchanged.

Should project redesign require additional facilities, the overall environmental impact, as discussed in Chapter III, would be increased. Such an increase would probably be directly proportional to additional surface area required for added facilities.

Washery sites

Proposed site for the washery was selected as a result of intensive engineering and economic studies. Relocation of the washery to the central maintenance complex, to one of the mine portal areas, or to the generating station complex is feasible.

Relocation of the washery to the central maintenance complex or to one of the mine portals would not change environmental impacts caused by the proposed project. Either alternative would aggravate adverse impacts of the project, specifically by requiring additional conveyor belt linkages from each mine to the washery in place of a single trunk line belt conveyor as presently proposed. Surface intrusion of the project would be increased.

Relocation of the washery to the generating station complex would offer a partial mitigation to environmental impacts associated with the coarse refuse dump. However, the overall adverse impact of the project would probably be slightly increased.

If the washery were located near the generating station, the coarse refuse dump could be combined with the ash disposal area. A coarse refuse/ash disposal dump would be smaller than the combined area of individual dumps since fine ash would tend to fill voids formed by deposition of coarse refuse. Fine tailings would continue to be deposited in a separate dump since water contained in fine tailings could leach trace elements from the ash, creating an opportunity for surface or ground water pollution.

A washery near the generating station would require, at minimum, a larger conveyor belt from the mine area to the new washery site and could require construction of a second parallel belt conveyor. In either case, an additional 3 million tons per year of material would have to be transported to Fourmile Bench.

A washery near the generating station would provide a net mitigation of impacts attributable to the present proposal. If two conveyor belts were required, there would be no net adverse or favorable environmental impact, only a transfer of surface impacts from one location to another.

Utah Power & Light power line to coal mine - Fourmile Bench

The following are alternatives to the proposed 230 kV power line from Butler Valley to the coal mine and generating station. This line would provide power for coal mine operation and for construction of the the generating station.

Alternate No. 1

The first 14 miles of Utah Power & Light Company (UP&L) power line would follow the same routing to the head of Wesses Canyon as the proposed line described in Chapter I. The line would then proceed down Wesses Canyon following the general alignment of the new highway and terminating at the coal mining facilities at Wesses Cove. This alternate line would be 22 miles long. A 3-mile temporary tap would be installed to the Fourmile Bench plant as described in Chapter I (see Illustration VIII-16).

The impacts of this alternative would be the same as described in Chapter III. However, the 8-mile segment of this route following the new highway alignment would create an additional visual impact for users of the highway. Also 4 miles of this 8-mile segment would contain the proposed new highway, the coal conveyor system and its power line, and the proposed UP&L power line. The canyon bottom is narrow and would possibly not allow for construction of all these components.

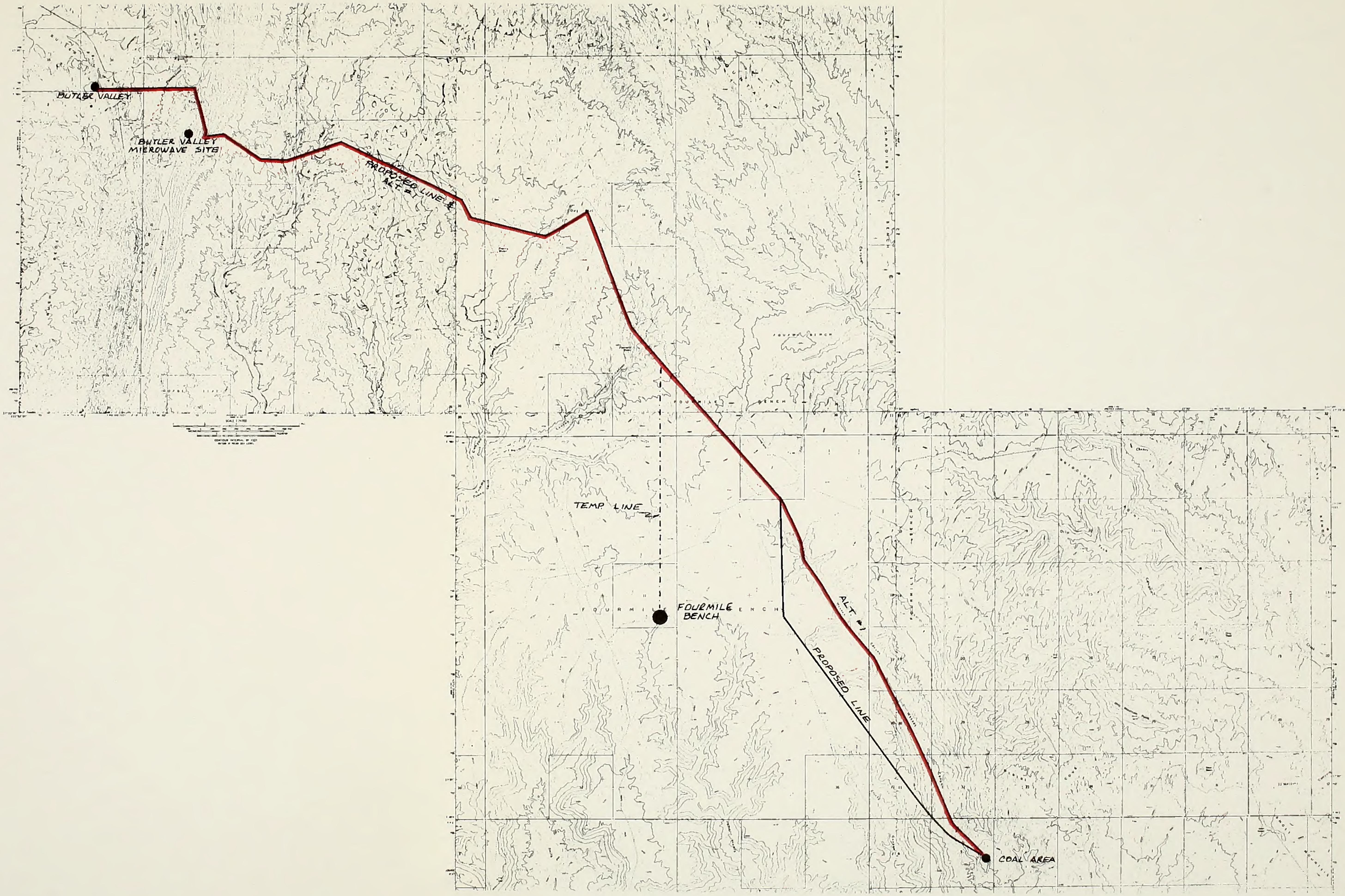

ILLUSTRATION VIII-16

UP&L Power Line Alternate No. 1

Alternate No. 2

Utah Power and Light would construct a 230/138 kV substation about 1/4 to 1/2 mile south of where the UP&L 230 kV line crosses U.S. 89 near Glen Canyon City. An alternate 138 kV line would proceed in a northerly direction from the substation paralleling the proposed Nipple Bench south 500 kV transmission line corridor. The line would follow the 500 kV corridor to the west edge of the proposed Nipple Bench plant site and from there would proceed due north approximately 2.5 miles where it would generally follow the new highway to the coal mining area at Wesses Cove (Illustration VIII-17). The permanent 138 kV line would be approximately 16.5 miles; the length of the temporary line would be approximately 7.5 miles. This alternative line would require an additional 5.5 miles of permanent construction and 4.5 miles of temporary construction than the proposed route. Also an additional 6 miles of access roads would be needed. The acreage disturbance for this alternative would be 15 acres greater than the proposed route.

Alternative No. 2 would place the power line through the middle of the proposed town on East Clark Bench. The line would present a visual intrusion and could possibly conflict with housing construction. Placing the power line underground in the new town could eliminate these impacts. The route would also parallel the new highway for approximately 6 miles and would possibly be a visual intrusion for that distance along the highway. Approximately 5,060 vehicles per day would travel this route.

Power line communication sites for Alternate No. 1

Plateau site

At the Plateau site there is an existing microwave repeater station with an access road, small cinder block building, and a 20-foot tower with 3 dish type antennas. The station is enclosed by a chain link fence. The plateau is located at T. 25 S., R. 1 W sec. 11. Additional facilities would include a 10 foot dish

type antenna and associated radio equipment. There would be no disturbance to the surrounding vegetation.

Henderson Peak site

At Henderson Peak there is an existing television translator with an access road, small cinder block building and power line providing electrical service. An additional building, 20-foot tower with 10-foot dish type antennas, and a chain link fence surrounding the tower and building would be located at this active microwave repeater site. The maximum height of the antennas would not exceed the present height of the trees. Henderson Peak is located in the Dixie National Forest in T. 35 S., R 3 W., sec. 35.

Butler Valley site

The Butler Valley microwave passive repeater site would be located at T. 39 S., R. 1 E., sec. 8. The construction of the passive repeater on a 40 by 40 foot plot would be aided by use of helicopters. Site grading, access road construction and disturbance of the vegetation would not be necessary. The passive repeater would not be fenced. Electrical service would not be required. The repeater would be located on a ridge and painted to blend with the surrounding juniper trees. It would be located 1.2 miles from the road and extended 24 feet above the horizon. The impacts associated with the communications sites would be the same as described in Chapter III for the proposed route.

Power line communication sites for Alternate No. 2

Barney Top site

The Barney Top site is an existing microwave active repeater with an access road, a small building and two 10-foot dish type antennas, mounted on a 200-foot tower. The building and tower, located at T. 35 S., R. 1 W., sec. 15, are surrounded by a chain link fence. The proposed additions would include a 10-

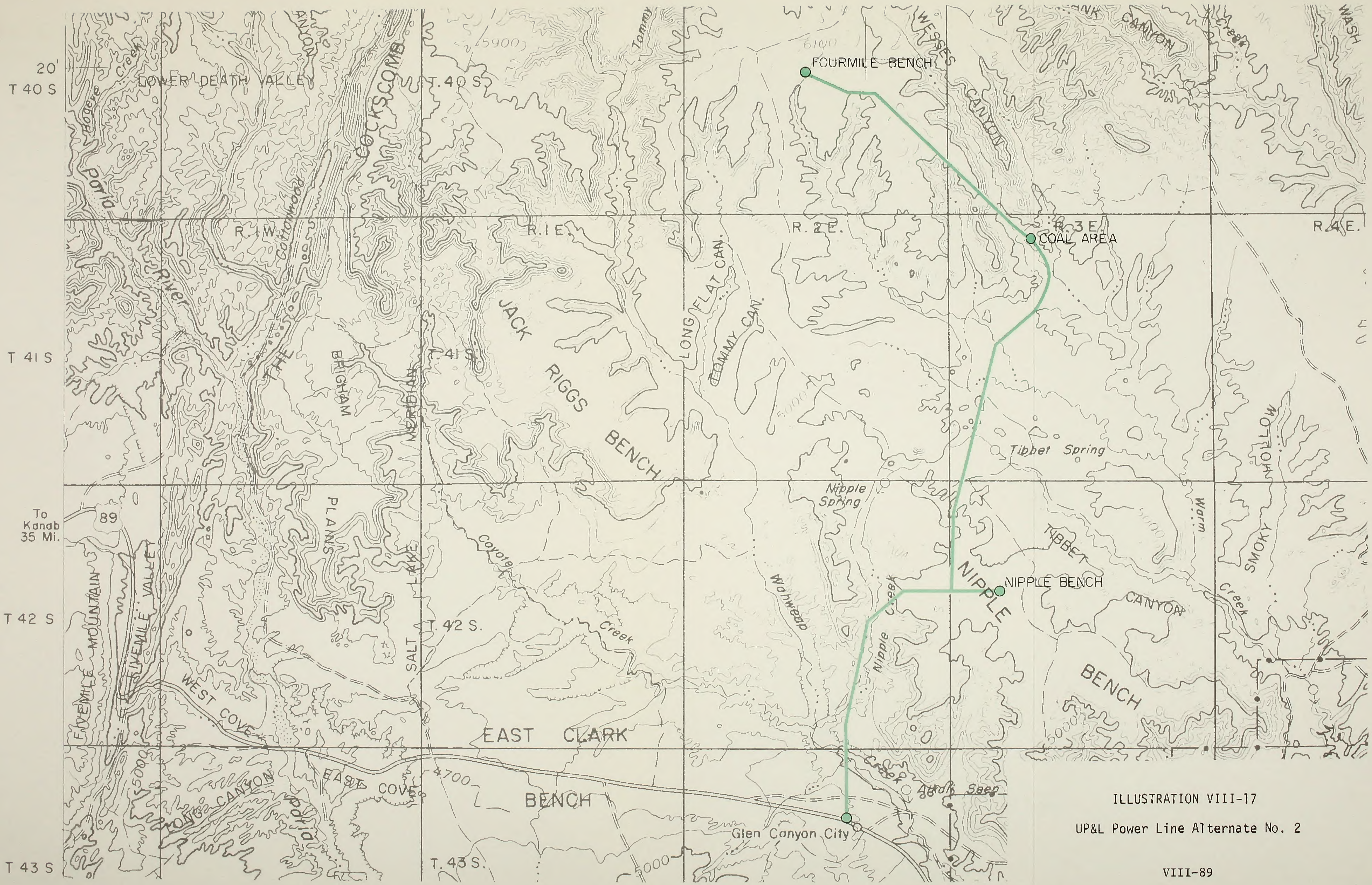

ILLUSTRATION VIII-17

UP&L Power Line Alternate No. 2

10-foot dish type antenna mounted on the same 200-foot tower. Associated radio equipment would be located in the existing building. There would be no disturbance to the surrounding vegetation.

Cedar Mountain site

There is currently a television translator site at Cedar Mountain with an access road running to the site. A 500 kV and a 69 kV power line extend over the top of the mountain near the radio site. The microwave passive repeater 40 x 40 foot square, would be located in T. 44 S., R. 2 E., sec. 4. Site grading and disturbance to vegetation would not be necessary. The passive repeater would not require electrical service. A chain link fence would enclose the passive repeater. The site would be located on top of the mountain, but not visible from U.S. Highway 89 or the new town.

Land use for substations

Power line substation area (230/138 kV) would be approximately 250 by 300 feet (1.75 acres), plus access road into the Butler Valley and Glen Canyon City substation sites covering approximately 1/2 mile (25 feet wide) (1.55 acres) for each road.

Distribution substation area (138/13.8 kV) would be approximately 1 acre. There would be no access road requirement since the site would be located in the plant construction area.

Land use requirements for the UP&L power line alternative sites are summarized as follows:

Land Use for UP&L Power Line Alternative - Fourmile Bench

Length of Power Line

	Permanent Line	Temporary Line to Fourmile Bench
Proposed Route	22 miles	3 miles
Alternate No. 1	22 miles	3 miles
Alternate No. 2	16.5 miles	7.5 miles

Right-of-Way Required

		Temporary Line to Fourmile Bench
Proposed Route	213.3 acres	29.1 acres
Alternate No. 1	213.3 acres	29.1 acres
Alternate No. 2	160.0 acres	72.7 acres

Land Occupied and Disturbed

	Permanently Occupied[a]	Temporarily Disturbed[a]
Proposed Route	8 acres	27 acres
Alternate No. 1	8 acres	27 acres
Alternate No. 2	11 acres	39 acres

Access Roads Required

	Main Access	Spur Roads
Proposed Route	5 miles	9 miles
Alternate No. 1	4 miles	10 miles
Alternate No. 2	17 miles	3 miles

[a]By both permanent and temporary lines

Transmission system

Introduction

This section is an analysis of each alternate transmission system route identified for the proposed project. In order to avoid unnecessary repetition, please refer to appropriate sections whenever an alternate to a proposed route either follows another proposed route or another alternate. If differences between a proposed route and one of its alternates are not significant, no new narrative is added, and reference should be made to appropriate sections of Chapter II through VII.

Routes

The number of alternates identified for each segment of the transmission system is as follows:

a. Kaiparowits to Eldorado - 15 alternates

b. Kaiparowits to Phoenix - 6 alternates

c. Kaiparowits to Mohave - 8 alternates

d. Mohave to Serrano - 7 alternates

Some of these alternates involve deviations of only a few miles from the proposed route, while others are longer and replace 100 or more miles of a proposed route.

Kaiparowits to Eldorado

The proposed Kaiparowits to Eldorado alternate routes are shown in Illustrations VIII-18 through VIII-32.

Fivemile Valley alternate

Description of alternate action

The proposed Fivemile Valley alternate (Illustrations VIII-19 and VIII-21) would follow the proposed route for approximately 12 miles from the Kaiparowits

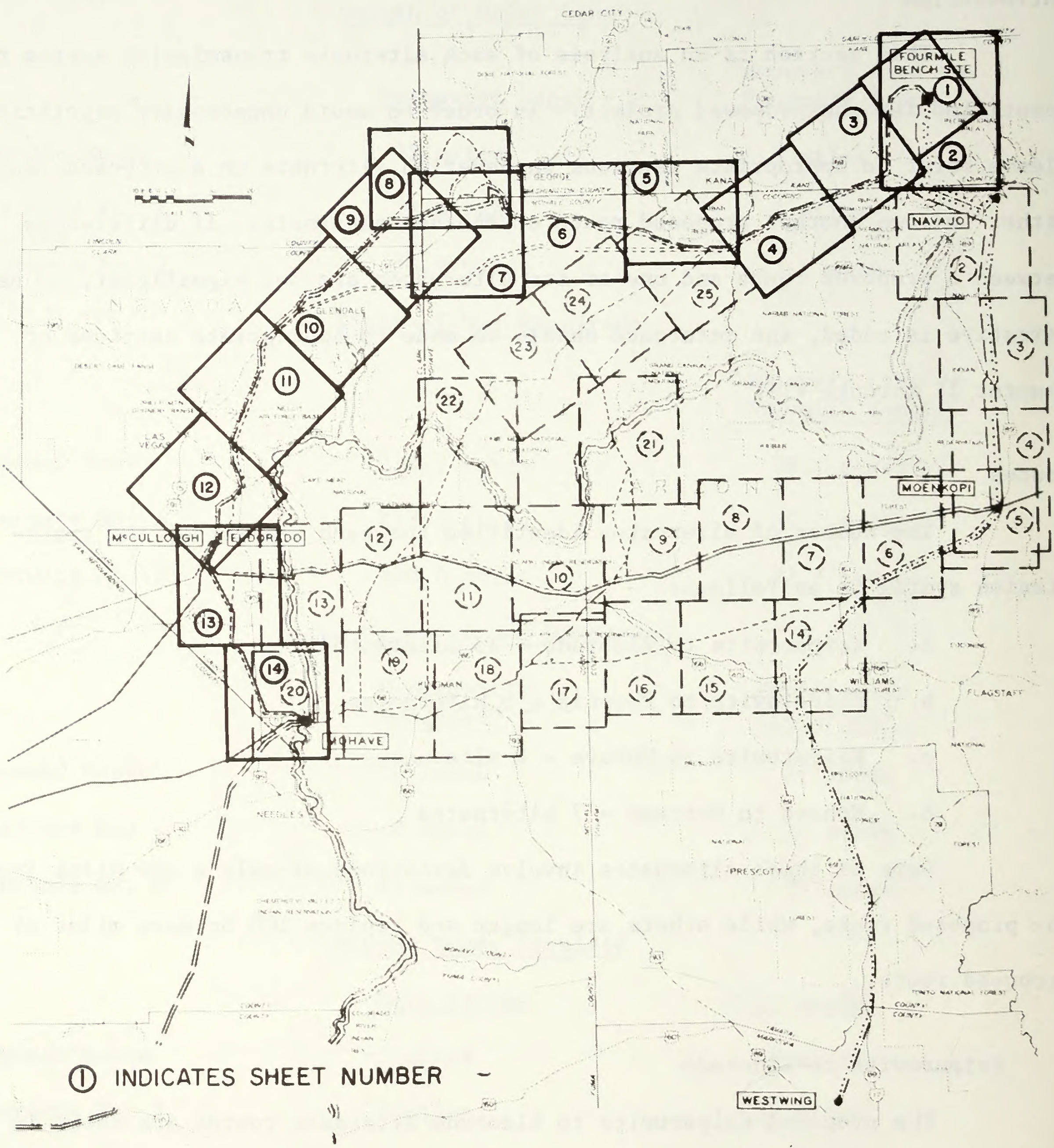

ILLUSTRATION VIII-18

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Index Sheet)

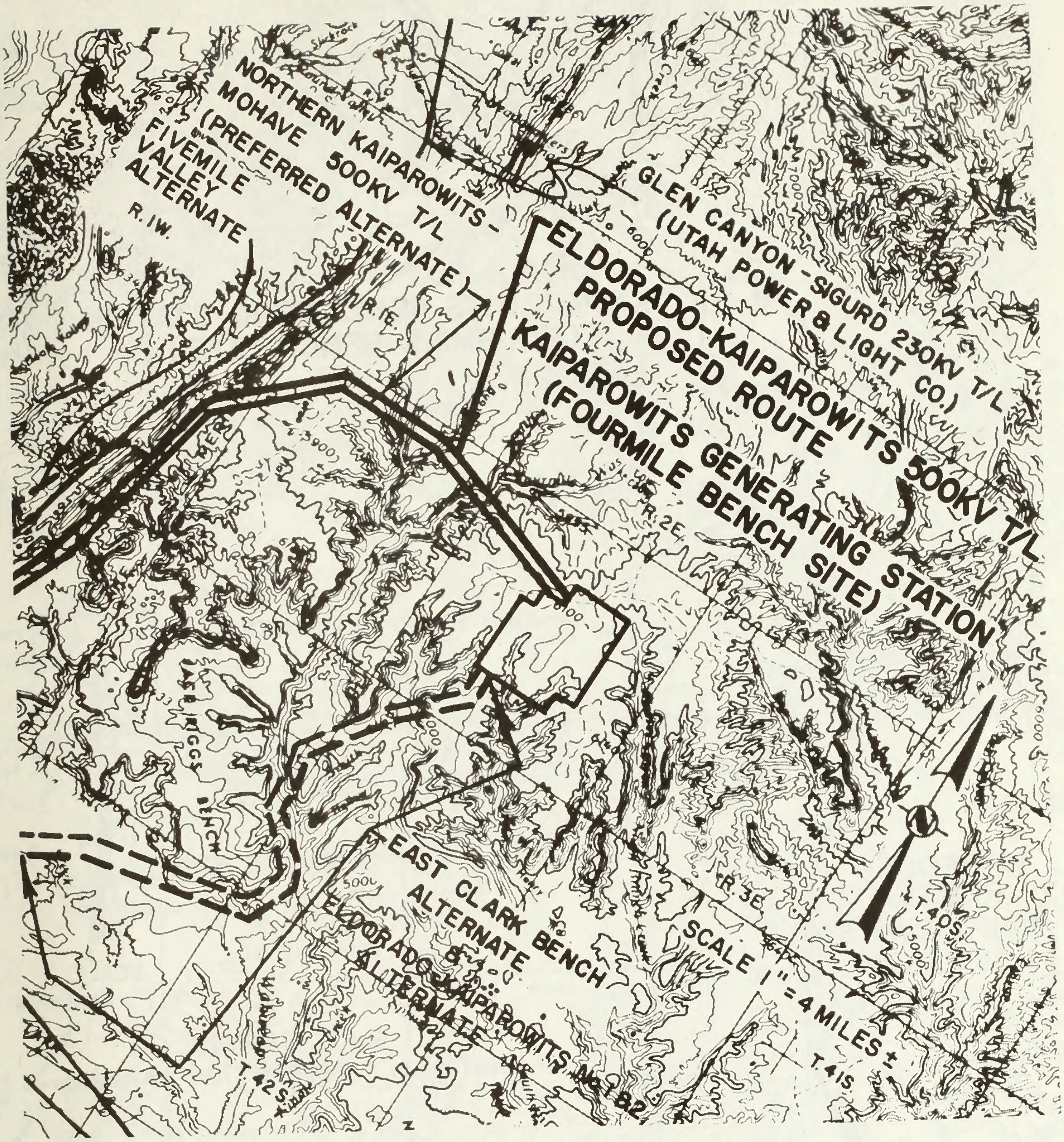

ILLUSTRATION VIII-19

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 1 of 14)

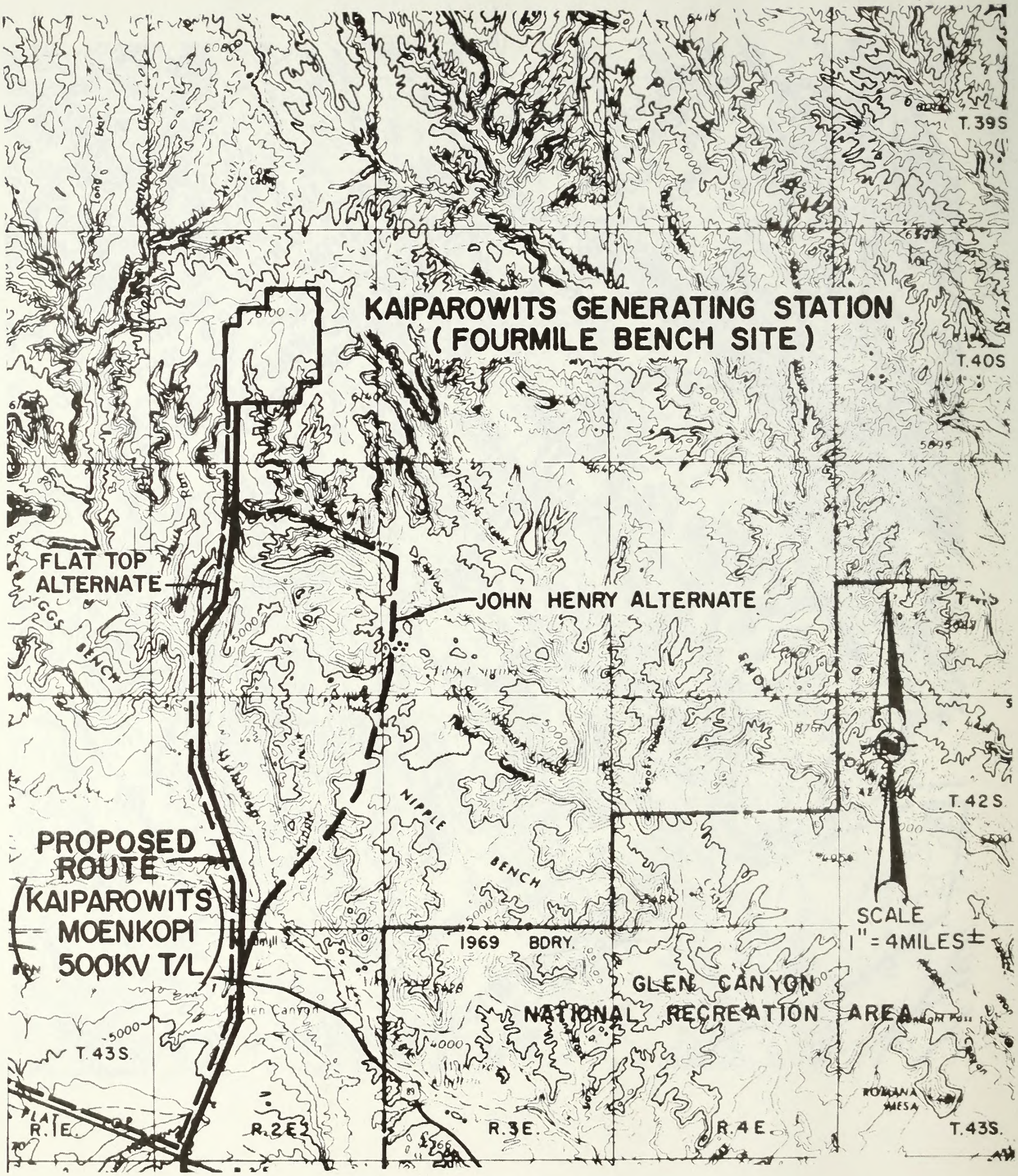

ILLUSTRATION VIII-20

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 2 of 14)

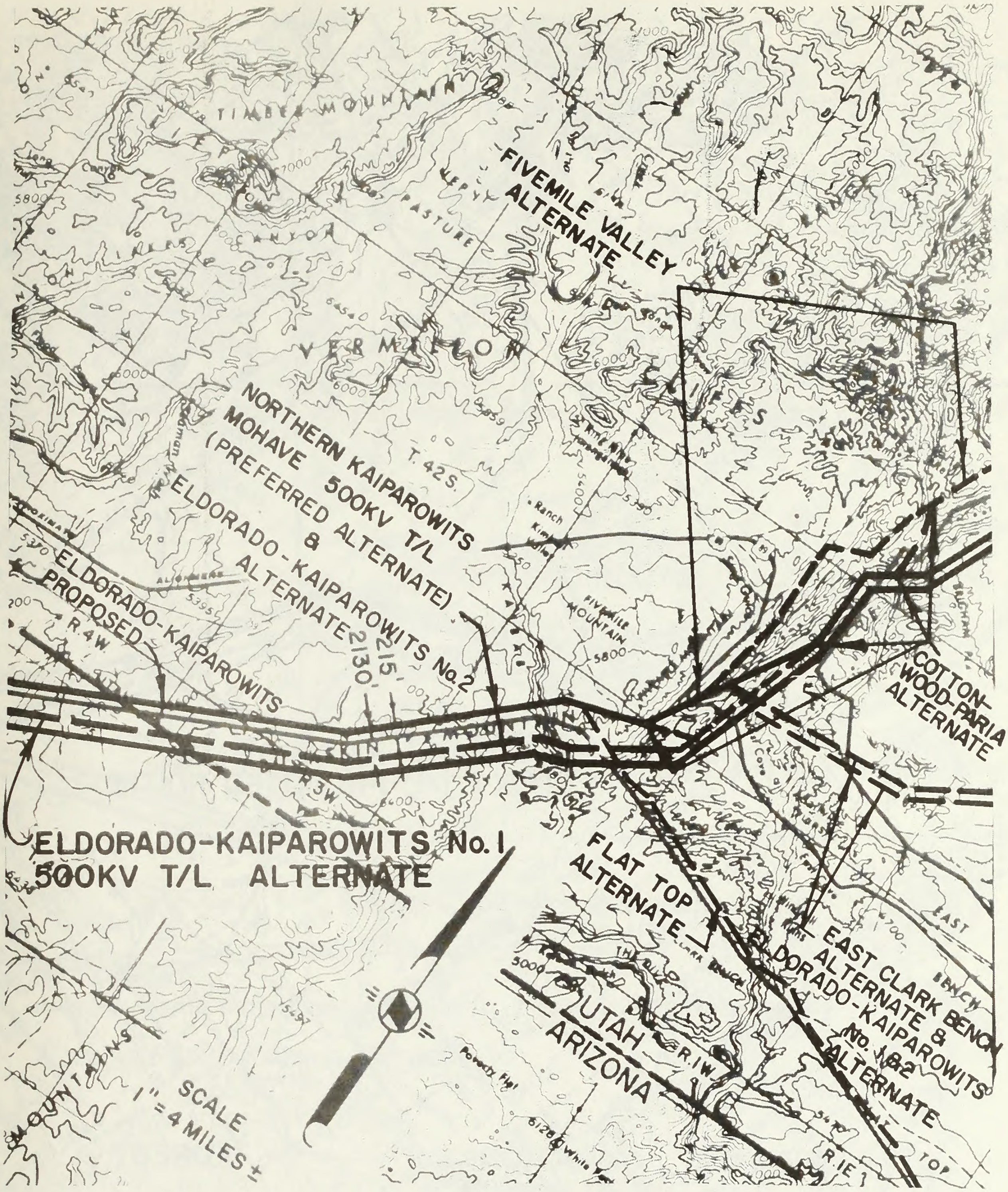

ILLUSTRATION VIII-21

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 3 of 14)

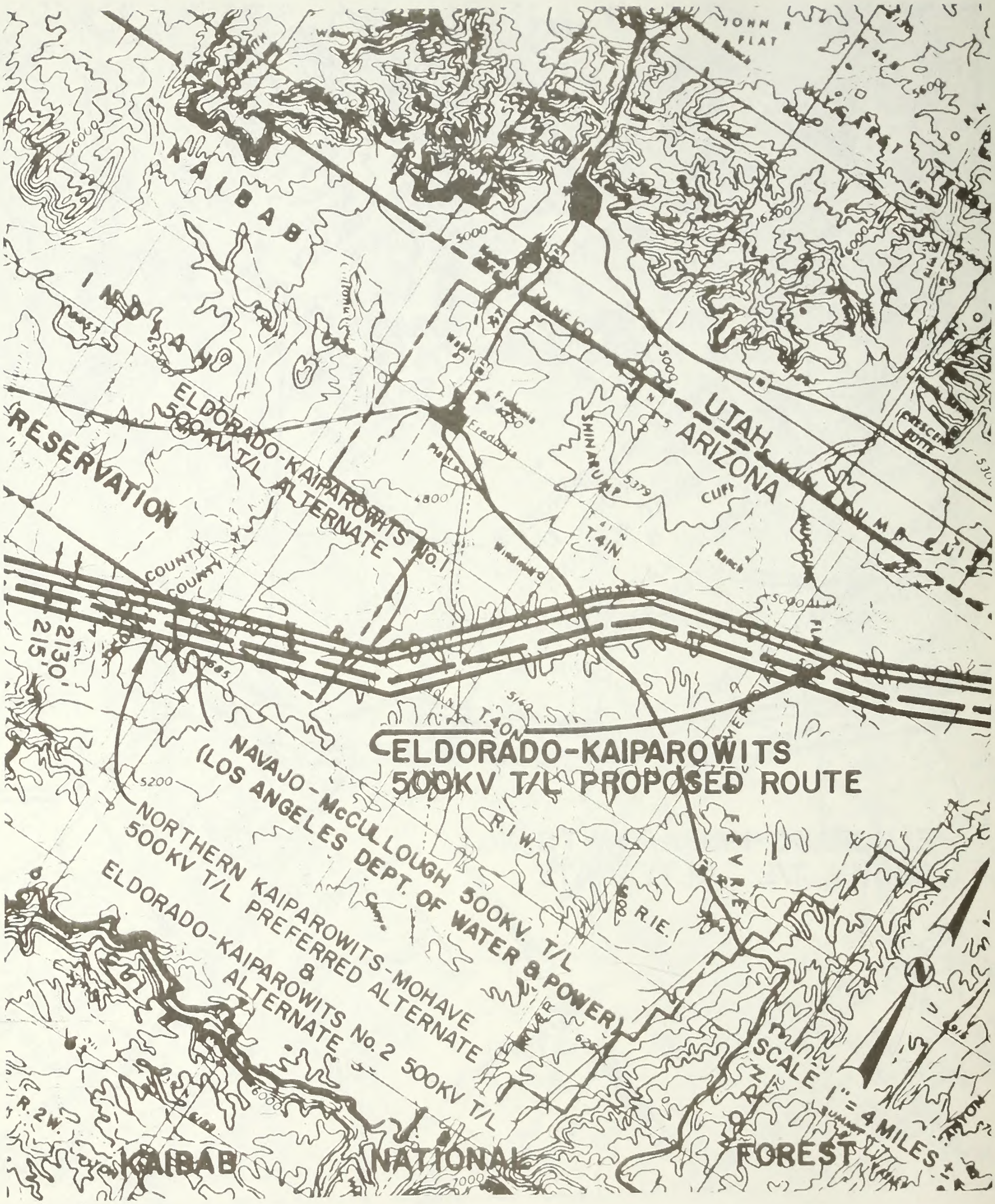

ILLUSTRATION VIII-22

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 4 of 14)

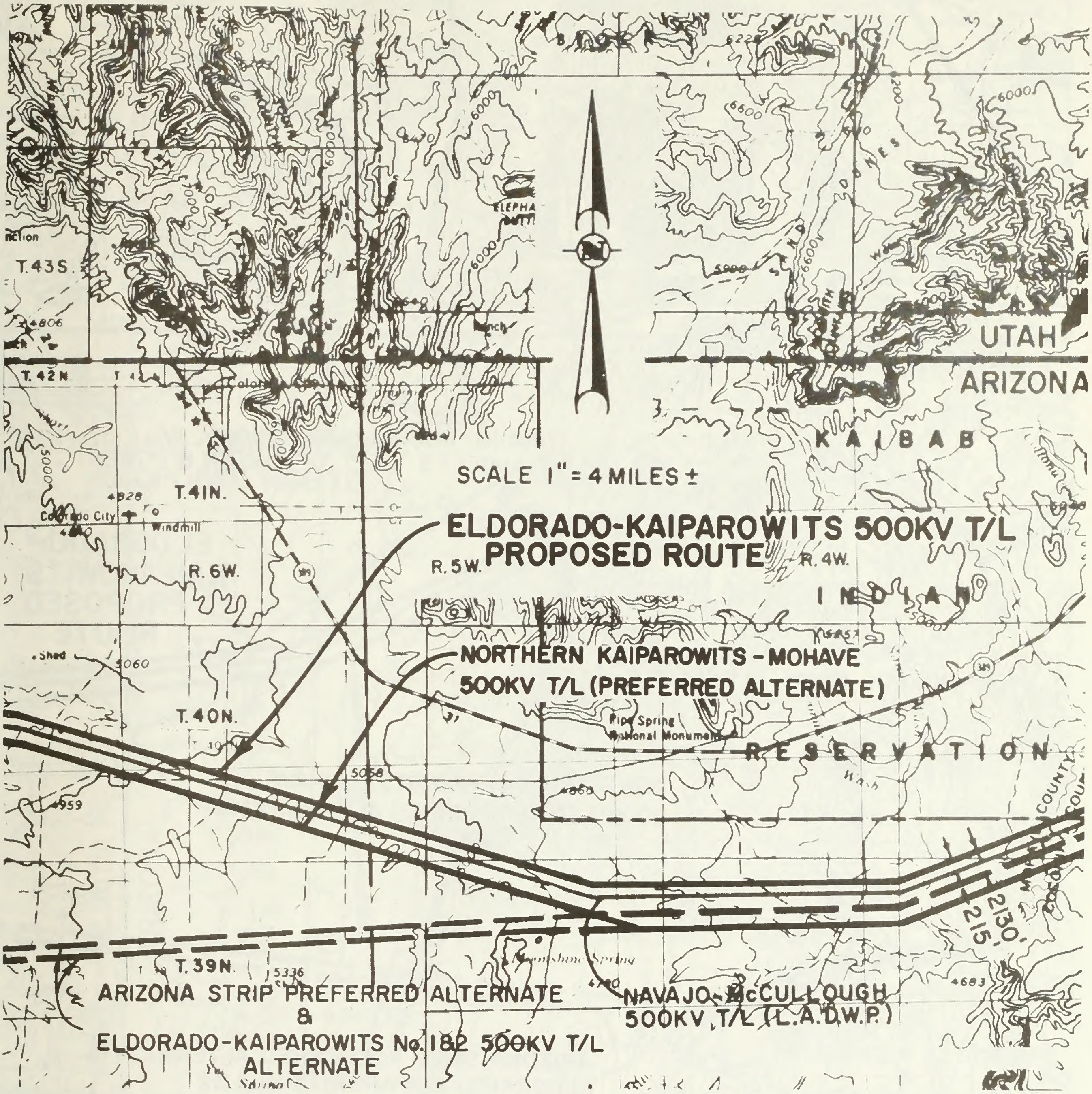

ILLUSTRATION VIII-23

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 5 of 14)

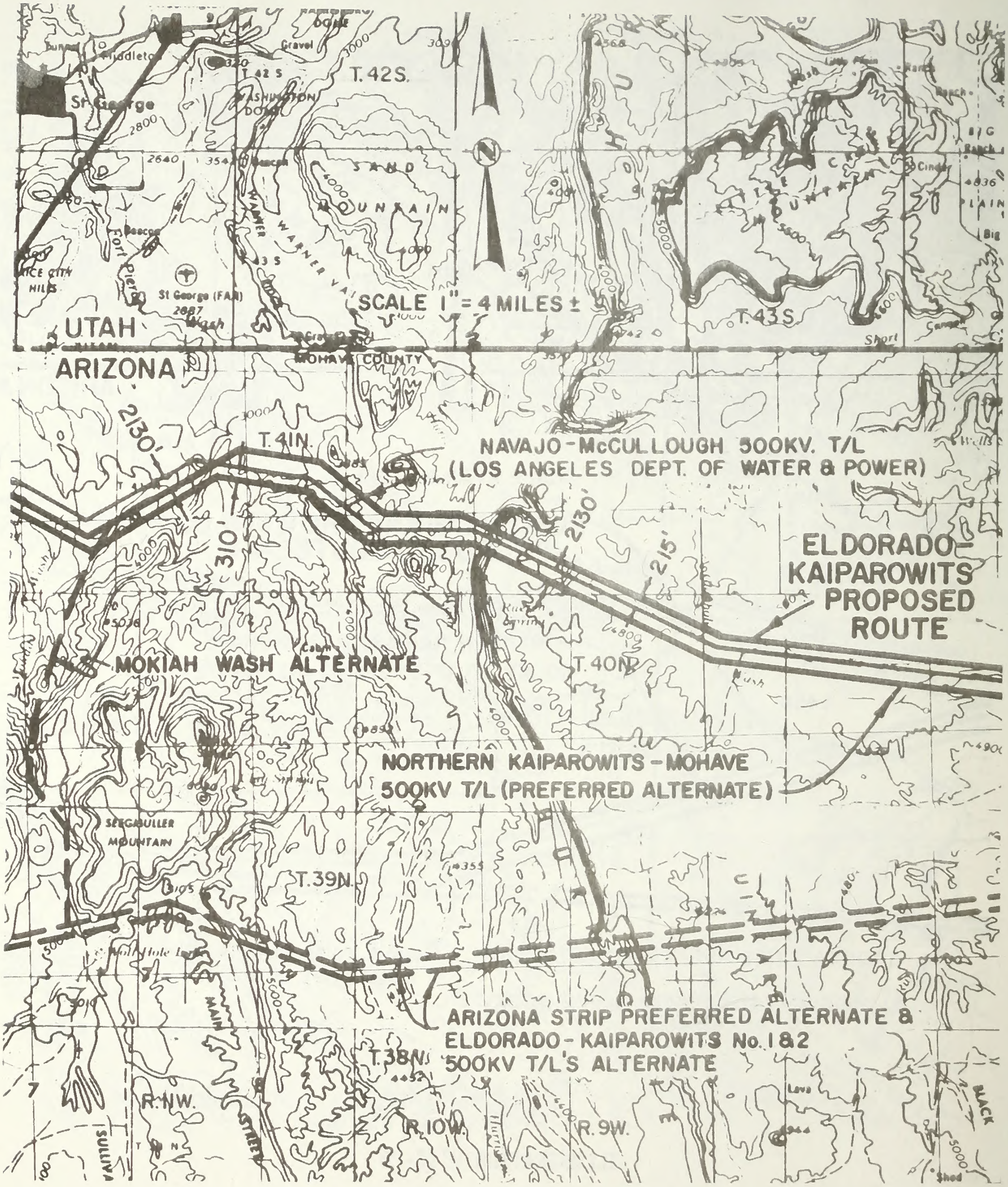

ILLUSTRATION VIII-24

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Sheet 6 of 14)

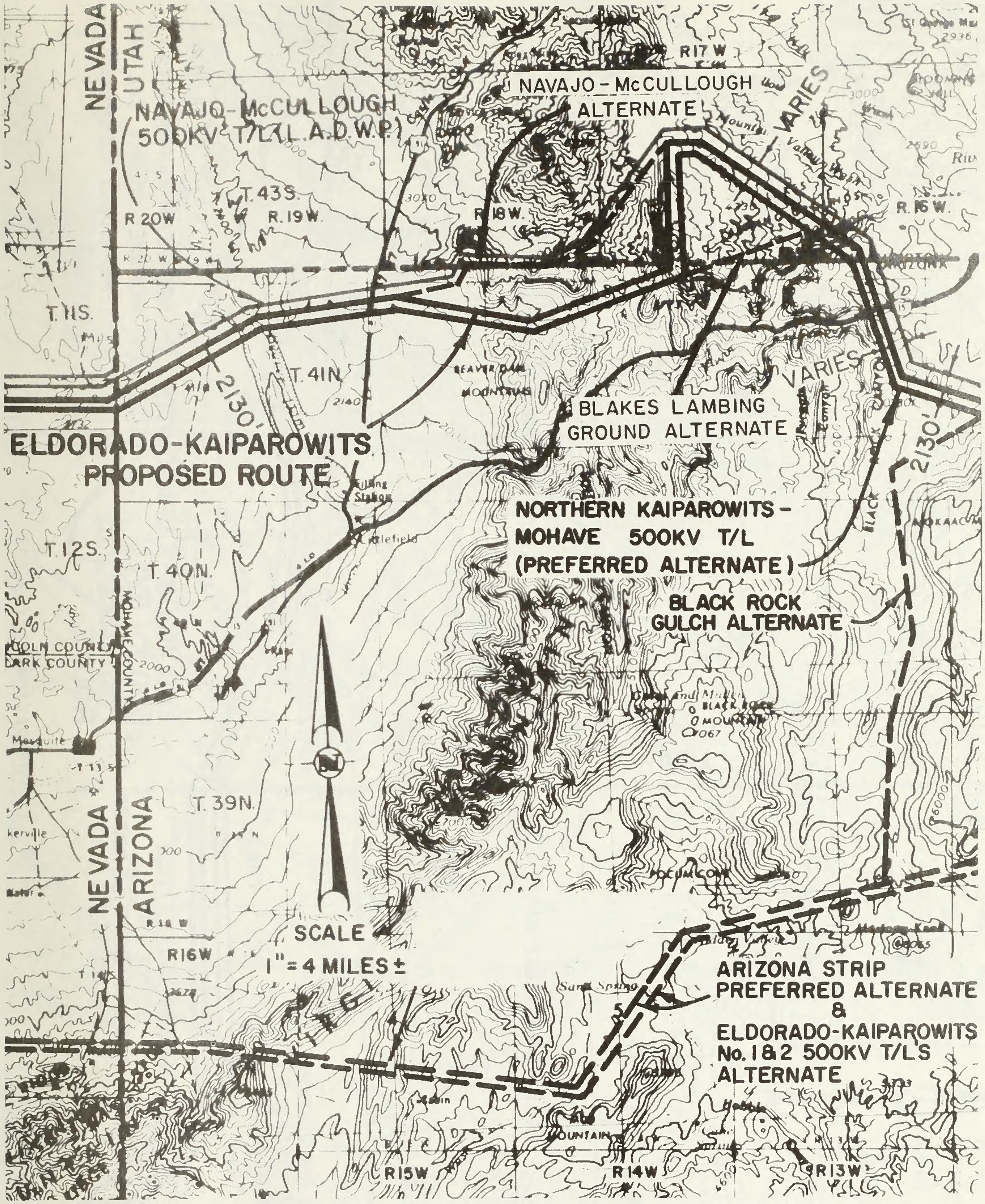

ILLUSTRATION VIII-25

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 7 of 14)

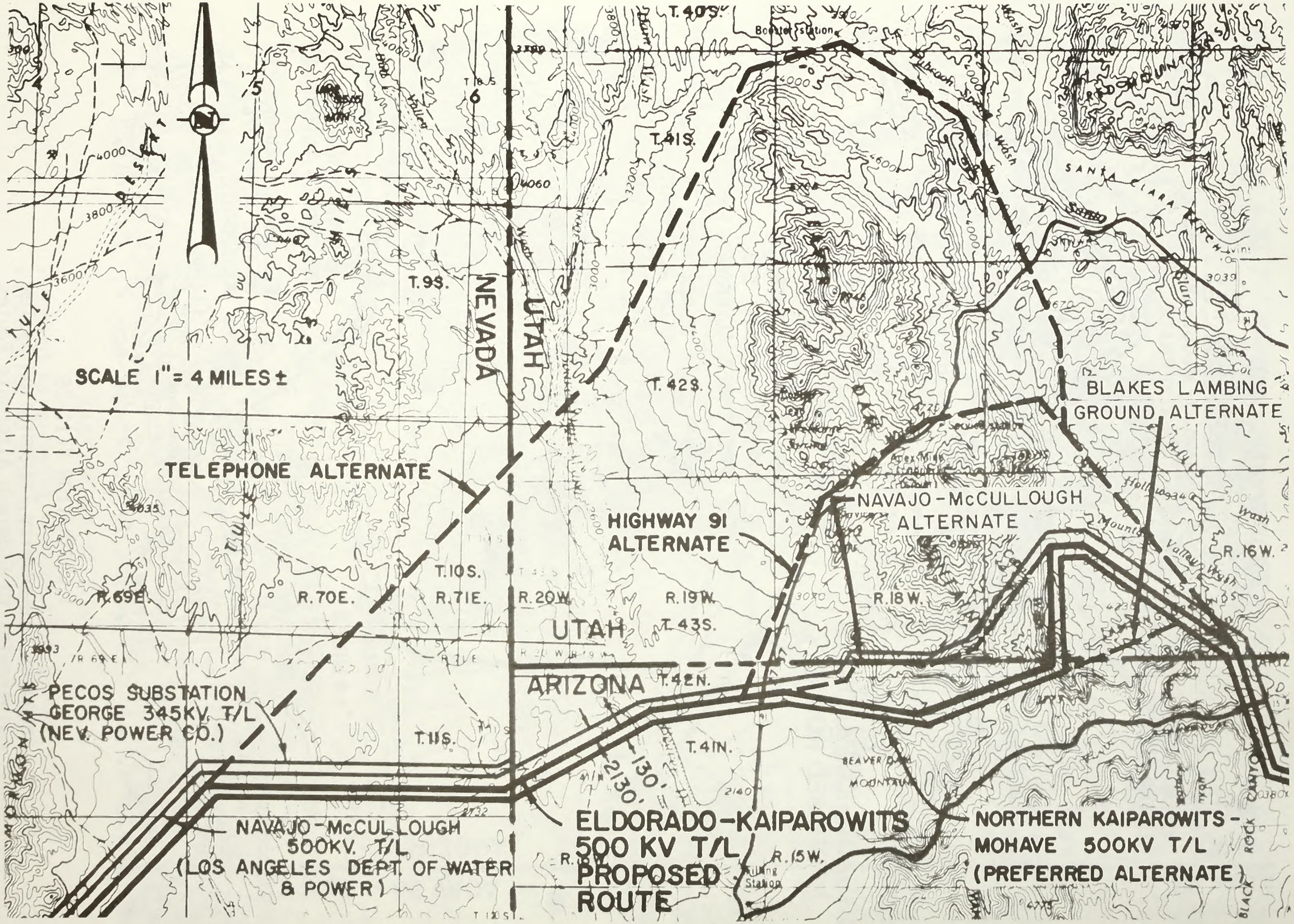

ILLUSTRATION VIII-26

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Sheet 8 of 14)

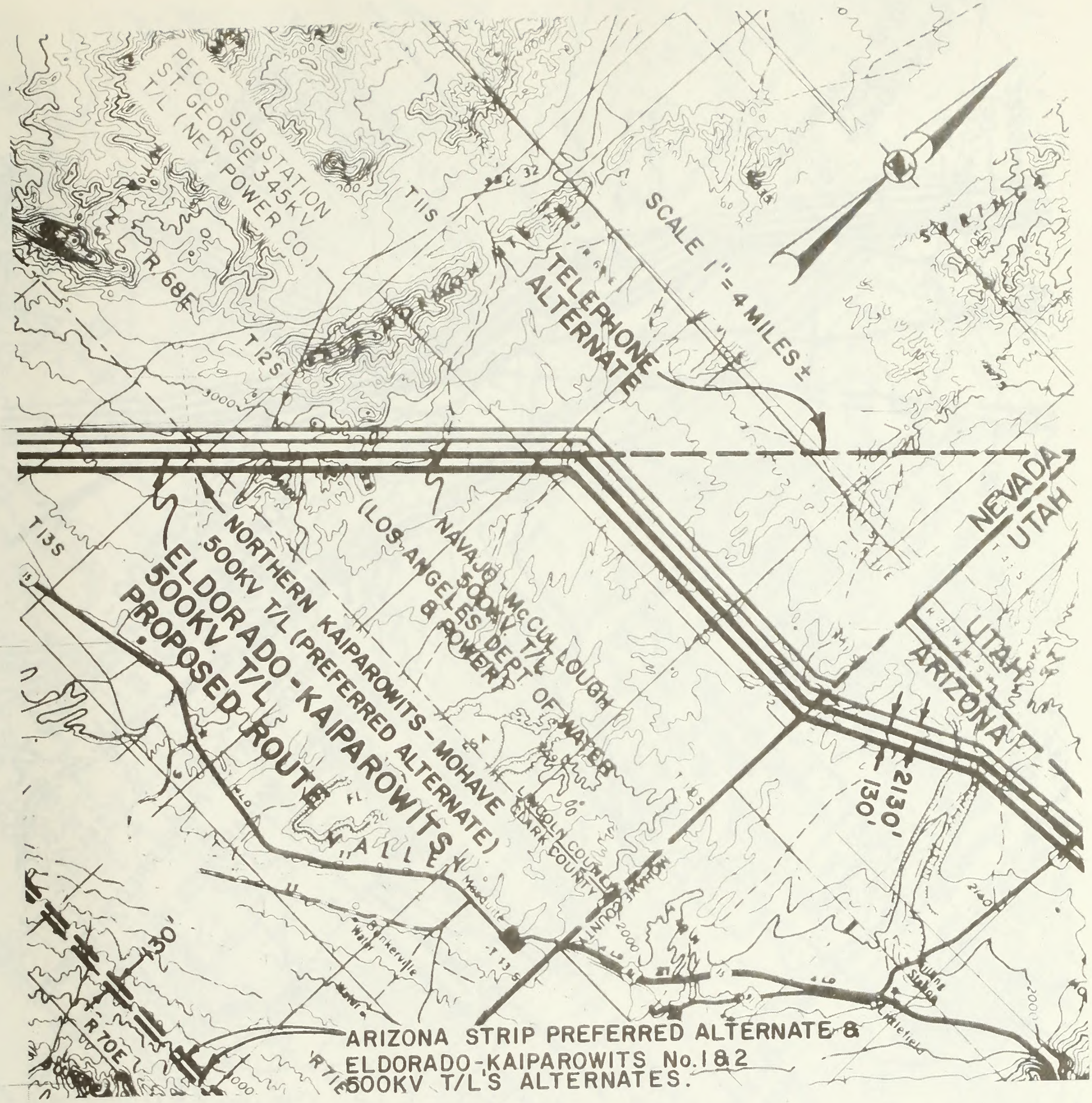

ILLUSTRATION VIII-27

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Sheet 9 of 14)

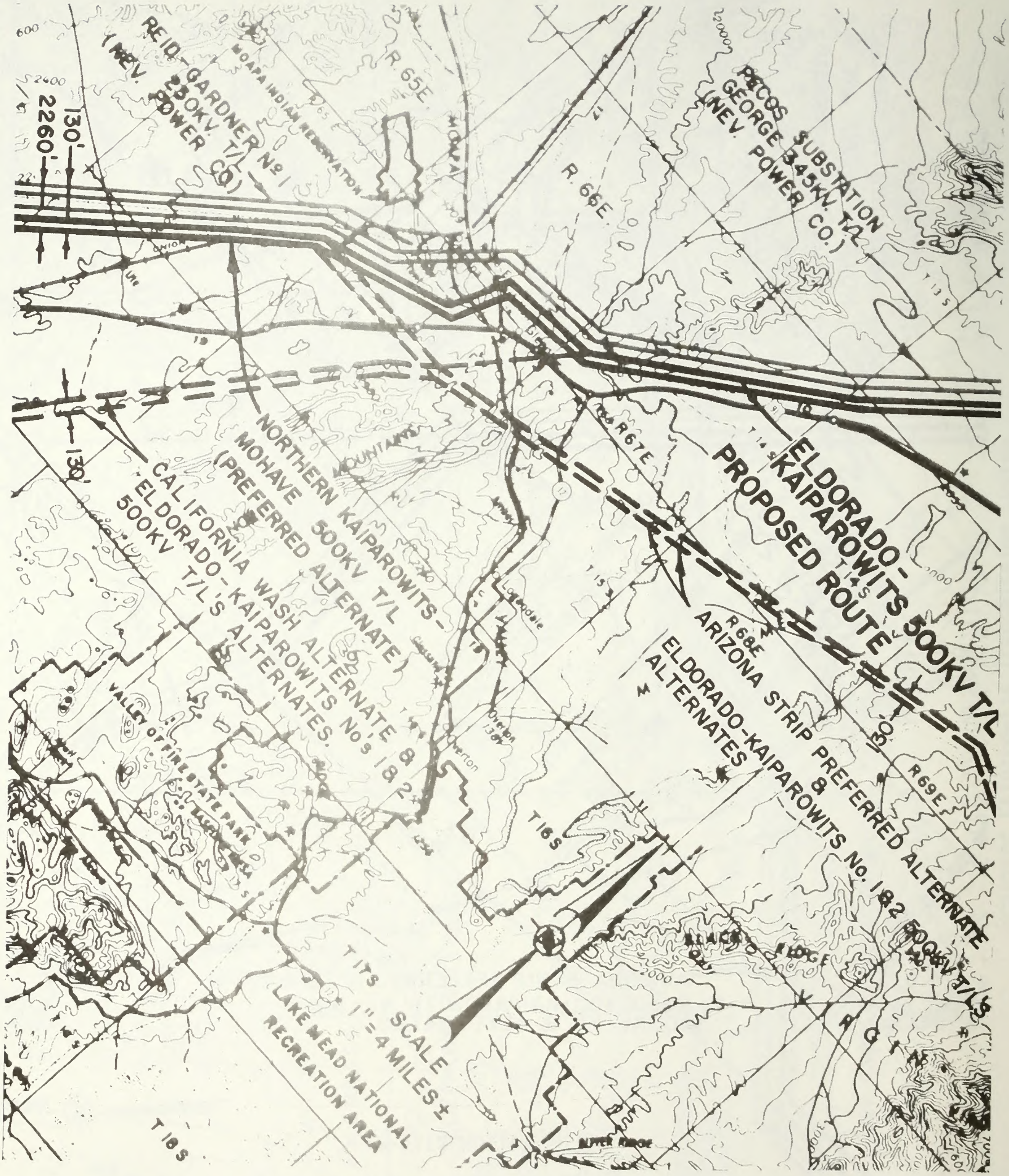

ILLUSTRATION VIII-28

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Sheet 10 of 14)

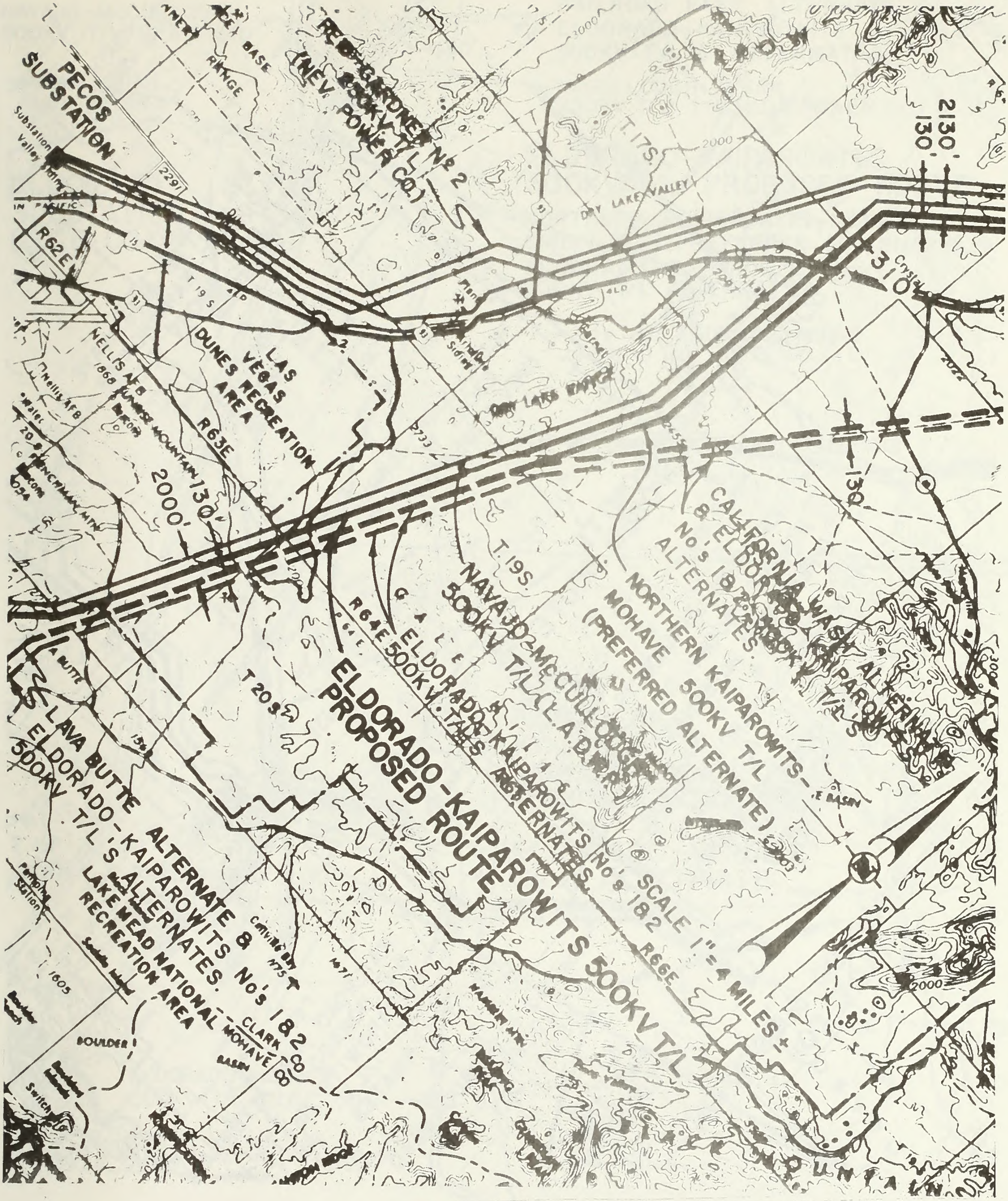

ILLUSTRATION VIII-29

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 11 of 14)

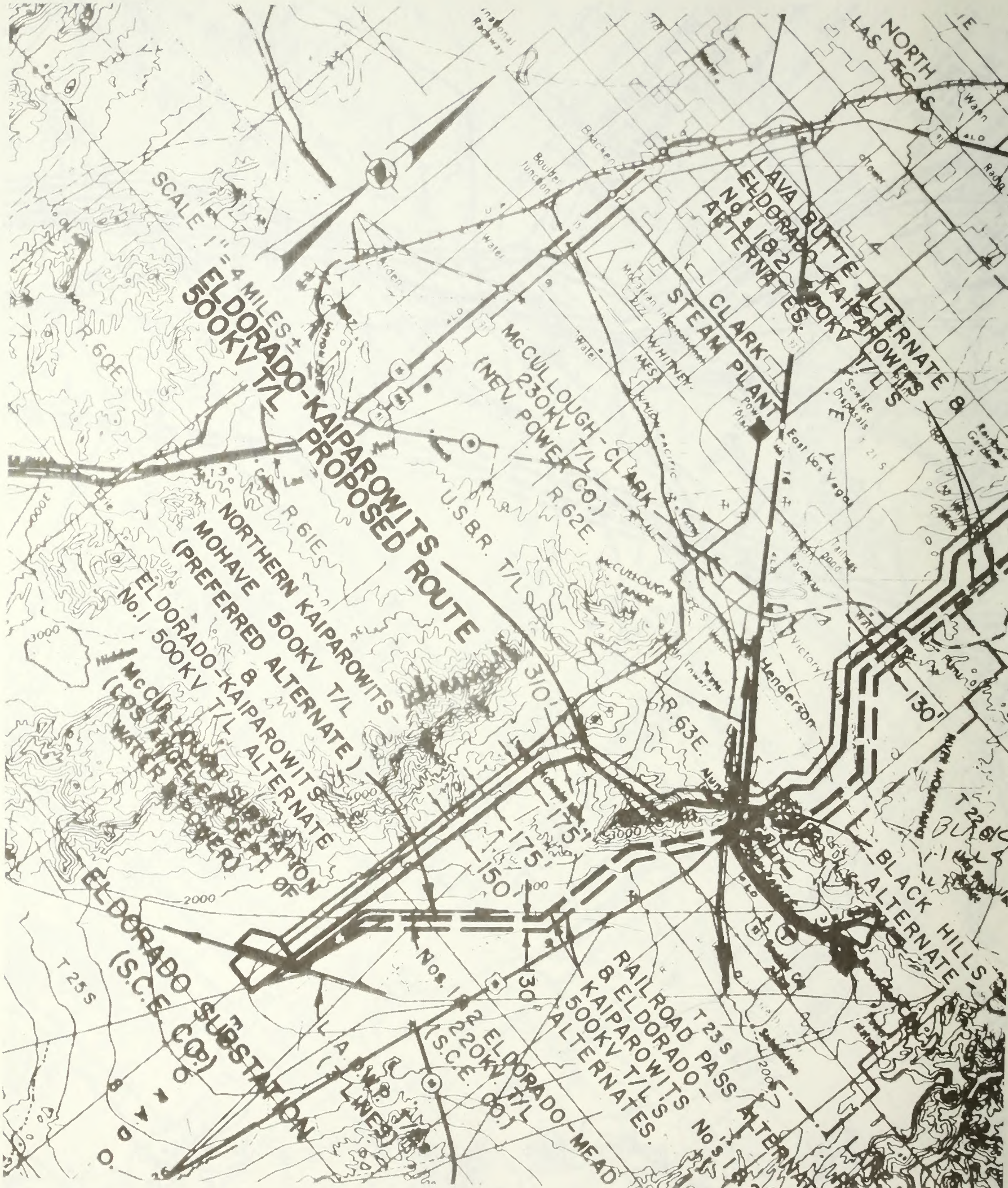

ILLUSTRATION VIII-30

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes

(Sheet 12 of 14)

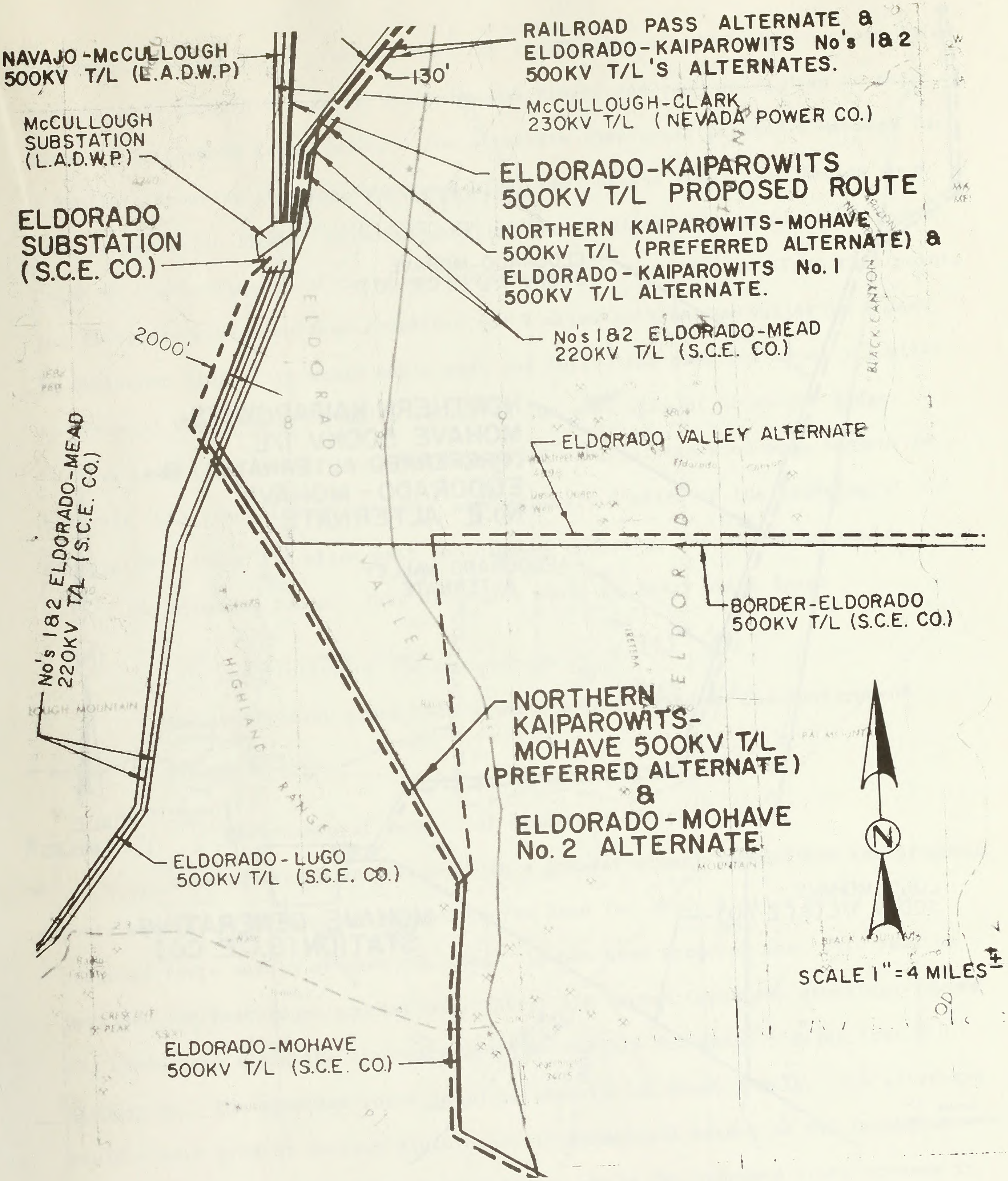

ILLUSTRATION VIII-31

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Sheet 13 of 14)

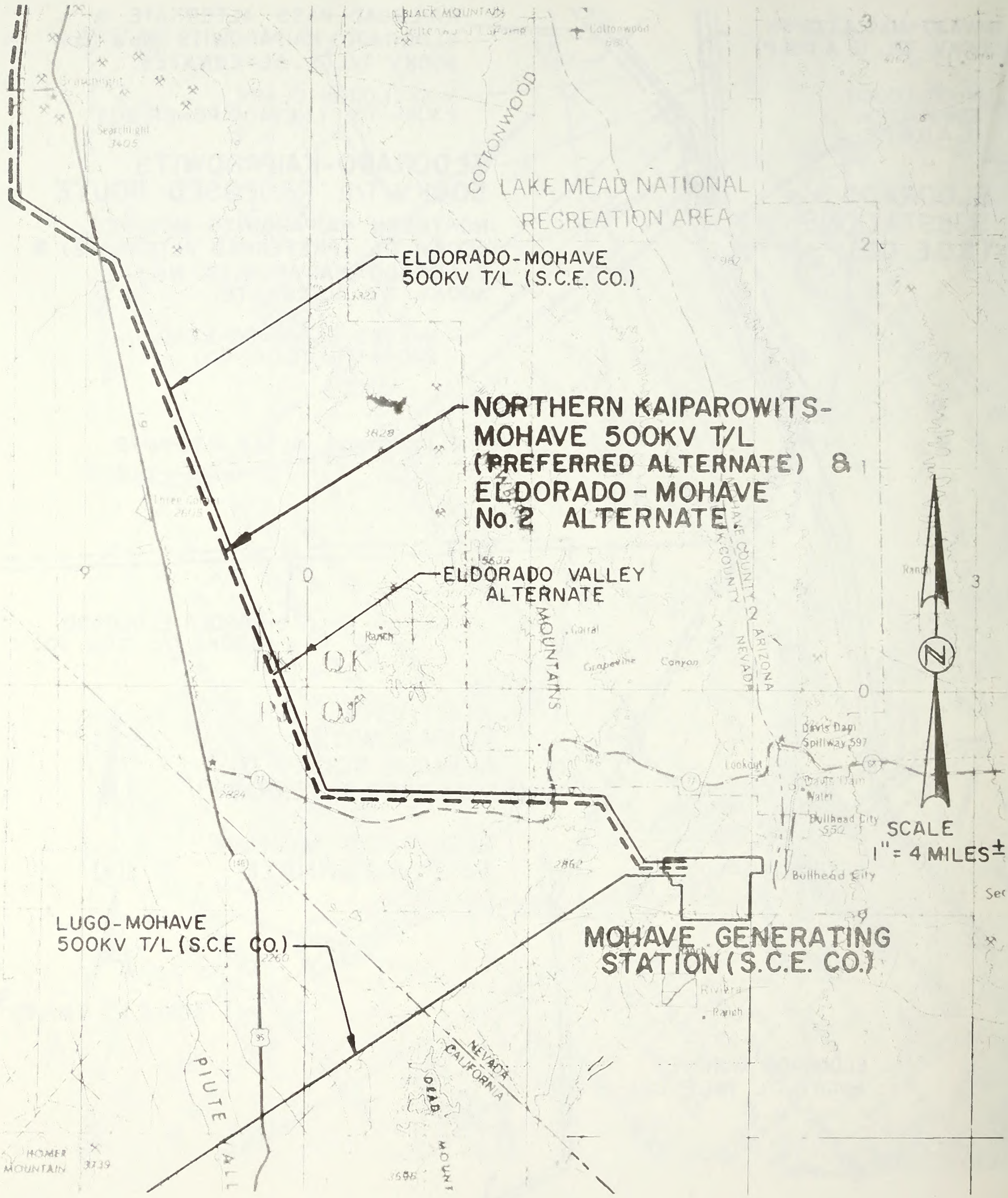

ILLUSTRATION VIII-32

Proposed Kaiparowits Transmission System
Kaiparowits to Eldorado Alternate Routes
(Sheet 14 of 14)

generating station site. Turning west for 1 mile, the alternate would cross Cads Crotch, pass through a draw in the Cockscomb Ridge, and then would drop to the floor of Cottonwood Creek Valley. The alternate then would proceed southwest for 3.9 miles, crossing the Utah Power and Light and Garkane Power Association wood pole transmission lines. It would parallel these existing lines down Cottonwood Creek to the confluence of Cottonwood Creek and the Paria River. From this point, the alternate would continue southeast for 2 miles up a narrow valley to a pass in Cockscomb Ridge. It would angle west and follow the pass for about 1.2 miles to where it would enter Fivemile Valley on the west side of Cockscomb Ridge. Turning toward the south, the alternate would parallel the wood pole Garkane 69 kilovolt (kV) transmission line for approximately 5 miles to the crossing of U.S. Highway 89. About 1.2 miles past the highway crossing, the alternate would rejoin the proposed route. This alternate would be 269.5 miles long.

Description of the environment

The environment along this alternate is similar to the environment along the proposed route.

Environmental impacts of alternate action

This alternate would result in a greater visual impact than the proposed route because it follows Cottonwood Canyon Road for about 6 miles while the proposed route merely crosses the road. It has been proposed that this road be upgraded for year-round tourist use. After the second Cockscomb crossing, towers and conductors along the alternate would be visible for about 5 miles from U.S. Highway 89. The proposed route would be visible for about 1 mile. The alternate would create greater surface disturbance (5 additional acres) on the Cockscomb Ridge because it crosses this feature twice, while the proposed route crosses it once. Other impacts would be similar to those of the proposed route.

Mitigating measures

Access roads would not be constructed where this alternate crosses Cockscomb Ridge. This measure would decrease the amount of surface disturbance.

Any adverse effects which cannot be avoided should the alternate be implemented

This alternate would result in greater visual impacts than the proposed route because it follows Cottonwood Canyon for 6 miles and it would be visible from Highway 89 for 5 miles.

Cottonwood-Paria alternate

Description of alternate action

The proposed Cottonwood-Paria alternate (Illustration VIII-21) would follow the Fivemile Valley alternate route for 18 miles to an angle point 0.25 mile north of the confluence of Cottonwood Creek and the Paria River. From here the alternate would angle to the south along the Paria River and would be adjacent to the Utah Power and Light 230 kV transmission line, and after 2 miles would rejoin the proposed route. After following the proposed route for 2.4 miles, the alternate would diverge in a more southerly direction traversing the lower elevations east of the Cockscomb for about 3 miles. The alternate would continue south for another mile after crossing Highway 89 and then turn southwest for 1.3 miles over the southern end of the Cockscomb and would rejoin the proposed route. This alternate would be 270 miles long.

Description of the environment

That portion of the alternate running along Cottonwood Creek and the Paria River follows two existing wood-pole lines. This area contains unusual geologic features of high scenic quality. Other environmental values would be the same as the proposed route.

Environmental impacts of alternate action

The Cottonwood-Paria alternate would result in the same impacts in Cottonwood Canyon as the Fivemile Valley alternate. The Cottonwood-Paria alternate and the proposed route both would be skylined where they cross Cockscomb Ridge south of Highway 89; however, the alternate would be more visible than the proposed route. All other impacts along the alternate would be similar to the proposed route.

Mitigating measures

Mitigating measures would be the same as those for the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Cottonwood-Paria alternate would produce visual impacts in Cottonwood Canyon and on Cockscomb Ridge near Highway 89. While the proposed route and alternate cross the same general area, the proposed route would not be as visible as the alternate. Otherwise, impacts would be similar to the proposed route.

East Clark Bench alternate

Description of alternate action

From the northwest corner of the Kaiparowits generating station, the proposed East Clark Bench alternate (Illustrations VIII-19 and VIII-21) would run southwest and south across Fourmile Bench and would gradually diverge from the proposed Kaiparowits to Moenkopi to Mohave route. After 4.6 miles, the alternate would drop off the bench into Smith Run and would continue southwest for 3.4 miles crossing the canyon diagonally, and then would rise to a low bench that separates Wahweap Creek from Smith Run. Turning south for 1.5 miles, the alternate would drop off the bench and cross to a high point on the west bank of Wahweap Creek. It then would proceed southeast for 2.5 miles parallel to the creek

channel along the base of Jack Riggs Bench. The alternate would then swing around the base of Jack Riggs Bench for 1.6 miles and proceed west-southwest for 4.5 miles. At this point the alternate would turn southwest for 4 miles, turn due west for about 5 miles and would rejoin the proposed route about 0.5 mile north of Highway 89. This alternate would be about 270 miles long.

Description of the environment

Topography along the East Clark Bench alternate is not as rugged and scenic as topography along the proposed route. Soils are similar to the proposed route except between Wahweap Creek and the Paria River. Along this 15-mile stretch, the alternate would cross shallow soils and rock outcrops. The erosion hazard of these soils is moderate to high, and if disturbed, the soil would have low potential for rehabilitation. The alternate would cross about 10 miles of mule deer habitat from the plant site to the edge of Fourmile Bench. The alternate would also cross the north edge of crucial pronghorn antelope winter range on East Clark Bench.

Environmental impacts of alternate action

By crossing about 15 miles of soils with moderate to high susceptibility to erosion and low rehabilitation potential, the East Clark Bench alternate could cause an increase in suspended sediment in the Paria River. It is estimated that disturbance of these soils would cause sediment-yield of soils in the area to increase a maximum of 1 acre-foot the year following completion of construction. If this sediment (about 2,400 tons) was carried to the Paria River, the sediment load in the river would increase about .03 percent. This increase would not have a measurable effect on water quality or aquatic wildlife.

Since it crosses about 17 fewer miles of mule deer habitat than the proposed route, this alternate would not have as great an impact on mule deer.

However, this alternate could result in a cumulative impact whereby antelope could be disturbed by construction activities on the east (Kaiparowits to Phoenix) and north sides of their winter range; such activities on two sides could prevent the antelope from using this range. In addition, improved access on two sides could increase the incidence of poaching.

This alternate would not have as high an impact on scenic quality as the proposed route because it would avoid most of the Cockscomb and Cottonwood Canyon areas.

Mitigating measures

All access roads would be obliterated and closed to travel between Wahweap Creek and the Cottonwood Canyon Road. This would prevent further disturbance of unstable soils after completion of construction, and would restrict access to antelope winter range.

Any adverse effects which cannot be avoided should the alternate be implemented

Since it crosses 15 more miles of sensitive soils than the proposed route, the East Clark Bench alternate would result in greater impacts on soils. This alternate would not have as much impact on mule deer because it crosses 17 fewer miles of habitat than the proposed route. However, construction activities on the north and east sides of East Clark Bench could prevent antelope from using crucial winter range.

Flat Top alternate

Description of alternate action

The proposed Flat Top alternate (Illustrations VIII-20 and VIII-21) would follow the East Clark Bench alternate to the point where it diverges west from the Kaiparowits to Moenkopi to Mohave route. From here the Flat Top alternate

would parallel the Kaiparowits to Moenkopi to Mohave route at a 200-foot separation for 21 miles to an angle point adjacent to but north of the Los Angeles Department of Water and Power (LADWP) Navajo-McCullough line. The alternate would follow the Navajo-McCullough line for 16 miles, again on a 200-foot separation, and would rejoin the proposed Kaiparowits to Eldorado route at the south end of the Cockscomb. This alternate would be 279 miles long.

Description of the environment

In most cases, topography along the Flat Top alternate is not as rugged and scenic as topography along the proposed route. Exceptions are an area of balanced rocks along Wahweap Creek several miles north of Glen Canyon City, and the Paria Canyon Primitive Area.

Soils along this route are fairly stable, and are not as susceptible to erosion as soils along the proposed route. In addition, soils along this alternate have a slightly higher potential for rehabilitation. This alternate crosses mule deer habitat similar to that for the East Clark Bench alternate. The pronghorn antelope habitat on East Clark Bench was described for the Kaiparowits Plateau impact area.

Environmental impacts of alternate action

Soils and vegetation along the Flat Top alternate would undergo higher impacts than along the proposed route because the alternate would create about 9 more miles of new corridor. This would amount to about 16 more acres of soils and vegetation disturbed. However, soils along this alternate are more amenable to rehabilitation. Mule deer along this alternate would undergo impacts similar to those described for the East Clark Bench alternate. The Flat Top alternate would also result in the same impacts on antelope as the proposed Kaiparowits to Phoenix route.

Visual vulnerability of this alternate would be greater than the proposed route because it would be visible from the proposed town site. Scenic values along the alternate are generally lower, with the exceptions of the area of balanced rocks and the Paria Canyon Primitive Area. Scenic impacts along this alternate would be less than the proposed route because the alternate would cross only a few miles of scenic areas whereas the proposed route would cross about 15 miles. In addition, the alternate would not be as visible at the Highway 89 crossing as the proposed route would be at the same crossing.

Mitigating measures

Supporting towers at the Paria Canyon crossing would be located so as not to be visible from the bottom of the canyon. This would reduce the visual impact of another transmission line crossing the Paria River Canyon.

Any adverse effects which cannot be avoided should the alternate be implemented

Although it would not result in visual impacts as great as those resulting from the proposed route, the Flat Top alternate would still produce visual impacts in the two small areas of unique scenery described above. In addition, this alternate would result in disturbance of 16 more acres of soil and vegetation than the proposed route.

Mokiah Wash alternate

Description of alternate action

The proposed Mokiah Wash alternate (Illustration VIII-24) would turn south from the proposed route about 12 miles west of the Hurricane Cliffs and follow Mokiah Wash for 11 miles to the edge of Seegmuller Mountain. At this point the alternate would meet the route of the Arizona Strip proposal. The alternate would then follow this route west until it connects with the California

Wash alternate near Glendale, Nevada. The alternate would then follow the California Wash alternate southwest for 25 miles to rejoin the proposed Kaiparowits to Eldorado route. The Mokiah Wash alternate would be 262 miles long.

Description of the environment

The environment along the Mokiah Wash alternate is generally the same as the environment along the proposed route, the Arizona Strip proposal, and the California Wash alternate. An exception is that the Mokiah Wash alternate would cross about 8 more miles of pinyon-juniper woodland than the Arizona Strip proposal.

Environmental impacts of alternate action

The Mokiah Wash alternate would result in a greater impact on the pinyon-juniper woodland community because it crosses 8 more miles of this community than the Arizona Strip proposal. Although the Mount Trumbull Road could be used for access along Mokiah Wash, the alternate would reduce scenic quality as viewed from the road. This alternate could also result in a greater impact on archaeological values because it would add 78 more miles of new corridor.

Mitigating measures

Mitigating measures for the proposed route, Arizona Strip proposal, and California Wash apply to the Mokiah Wash alternate.

Any adverse effects which cannot be avoided should the alternate be implemented

Unavoidable adverse impacts would generally be the same as for the proposed route, Arizona Strip proposal, and California Wash alternate. In addition, the Mokiah Wash alternate would result in disturbance of 8 more miles of pinyon-juniper woodland than the Arizona Strip proposal, reduced visual quality along the Mount Trumbull Road, and possible loss of archaeological values along 78 miles of new corridor.

Black Rock Gulch alternate

Description of alternate action

About 15 miles past the Hurricane Cliffs, the Black Rock Gulch alternate (Illustration VIII-25) would depart from the proposed route in a southwest direction along the base of Mokiah Mountain. After 3.6 miles the alternate would turn south and follow Black Rock Gulch for 11.4 miles to the Arizona Strip route. This alternate would be identical to the Mokiah Wash alternate from here on. The Black Rock Gulch alternate would be 267 miles.

Description of the environment

The environment along the Black Rock Gulch alternate is similar to the environment along the Mokiah Wash alternate.

Environmental impacts of alternate action

Environmental impacts of the Black Rock Gulch alternate would be similar to those discussed for the Mokiah Wash alternate.

Mitigating measures

Same as the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Adverse impacts would be the same as for the Mokiah Wash alternate.

Navajo-McCullough alternate

Description of alternate action

The Navajo-McCullough alternate (Illustrations VIII-25 and VIII-26) would leave the proposed route on the east side of the Beaver Dam Mountains. It would follow the existing Navajo-McCullough transmission line through Bulldog

Canyon to old Highway 91 and rejoin the proposed route west of the mountains. This alternate would be about 267 miles.

Description of the environment

Vegetation is the same as along the proposed route, except that the Navajo-McCullough alternate crosses about 4 miles of pinyon-juniper woodland community in the Beaver Dam Mountains.

The alternate route would cross Gambel's quail habitat in the Beaver Dam Mountains; however, this is not a crucial habitat as it is along the proposed route. Furthermore, quail habitat along the alternate has already been disturbed by the Navajo-McCullough transmission line.

This alternate would follow a utility corridor established through Bureau of Land Management planning. The proposed route would diverge from this corridor in the Beaver Dam Mountains. The purpose of such a corridor is to meet needs for utility rights-of-way and, at the same time, preserve natural values of other lands.

Environmental impacts of alternate action

Quail habitat along the Navajo-McCullough alternate has already been disturbed because of the existing corridor; another line would probably have little effect on quail. Conversely, the proposed route would cross undisturbed, crucial Gambel's quail habitat. In addition, the alternate would create 12 fewer miles of new corridor than the proposed route.

Mitigating measures

Mitigating measures are the same as for the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Disturbance of quail habitat would not be as great along the Navajo-McCullough alternate because it would follow an existing corridor. About 26 acres of quail habitat would be permanently disturbed by the alternate, but this habitat is not crucial to Gambel's quail.

Highway 91 alternate

Description of alternate action

The Highway 91 alternate (Illustration VIII-26) would leave the proposed route near Blake's Lambing Ground and cross the foothills of the Beaver Dam Mountains in a northwest direction for 9 miles. The alternate would then turn west-southwest for 3 miles and cross old Highway 91 in the mountains. It would then turn southwest and follow this highway for about 10 miles before rejoining the proposed route a few miles west of the Beaver Dam Mountains. This alternate would be 271 miles long.

Description of the environment

Highway 91 was a major transportation route, but it has been replaced by I-15 further to the south. The highway is still used by some travelers as a sightseeing route.

This alternate route passes through 3 miles of the Joshua Tree Natural Area, which was established for desert tortoises and Joshua trees in the southwest corner of Utah. The area represents the northern limit of the desert tortoise range and is crucial habitat. In addition, it is the only known desert tortoise habitat in Utah.

At the top of the Beaver Dam Mountains this alternate crosses a pass between two potential desert bighorn sheep reintroduction areas. If reintroduced

to these areas, bighorn sheep would probably use the pass as a migration route. This pass is also a migration route between two crucial mule deer winter ranges.

Environmental impacts of alternate action

The Highway 91 alternate would reduce scenic quality of part of the Beaver Dam Mountains and areas along old Highway 91. Since the alternate would create about 9 more miles of new corridor than the proposed route, it would result in about 19 more acres of soil and vegetation permanently disturbed.

This alternate route would probably have little effect, if any, on the migration of desert bighorn sheep if the sheep were reintroduced to the Beaver Dam Mountains. Construction of the line during winter months (November through February) could restrict or alter the normal migration of mule deer through the pass in the Beaver Dam Mountains. The alternate would reduce natural values and disturb crucial desert tortoise habitat in the Joshua Tree Natural Area. Impacts on raptors, Gambel's quail, and Gila monsters would be much less along the alternate than along the proposed route because the alternate would not cross habitat crucial to these wildlife species. From the standpoint of wildlife, this alternate would have the least effect of any of the routes, either proposed or alternate, that would pass through the Beaver Dam Mountains.

Mitigating measures

Access roads from Highway 91 to the alternate would be obliterated where the alternate crosses Joshua Tree Natural Area in southwest Utah. This would avoid permanent improvement of access to desert tortoise habitat.

Construction in the Beaver Dam Mountains would be limited to the period March through October. This would ensure that mule deer would be able to migrate to winter range.

Any adverse effects which cannot be avoided should the alternate be implemented

The Highway 91 alternate would reduce scenic and natural values along undisturbed land in the Beaver Dam Mountains and the Joshua Tree Natural Area. The alternate would also temporarily disturb desert tortoise habitat in the natural area.

Telephone alternate

Description of alternate action

The Telephone alternate (Illustrations VIII-26 and VIII-27) would follow the Highway 91 alternate for about 8 miles and then continue north and northwest for about 14 miles to the north end of the Beaver Dam Mountains. The alternate would then turn west-southwest across the north end of the mountains for 3 miles and then southwest for 26 miles to rejoin the proposed route east of the Mormon Mountains. This route would be 286 miles long.

Description of the environment

Topography along the Telephone alternate is flatter than along the proposed route since the alternate goes around the Beaver Dam Mountains rather than across. The alternate would skirt mule deer habitat and potential desert bighorn sheep habitat along the mountains. It would also cross a mule deer migration route between these mountains and the Red Mountains. This alternate would cross desert tortoise habitat between the north end of the Beaver Dam Mountains and the point where it rejoins the proposed route.

There is potential for archaeological and historical sites along this alternate, especially in the vicinity of Beaver Dam Wash. Although specific sites are not identified, there is always potential in undisturbed areas.

The alternate would cross the Shivwits Indian Reservation which is located about 10 miles northwest of St. George. About 6 miles of the route would be on the reservation.

Environmental impacts of alternate action

It is estimated that 15 more acres of soil and vegetation would be permanently disturbed along the Telephone alternate than along the proposed route. In addition, the erosion hazard of disturbed soils along this alternate could be high as compared to medium for the proposed route.

Construction activities and improved access to areas adjacent to the Beaver Dam Mountains could result in increased poaching of mule deer, harassment of desert tortoise, and loss of unidentified archaeological and historical values.

This alternate could remove about 40 acres of the Shivwits Indian Reservation from present uses which consist of grazing and farming rights leased to ranchers. This could eliminate these lands as a source of revenue for the Indians. However, fees paid by the participants would probably offset these losses. The significance of any other losses would probably be best determined by the Indians.

Mitigating measures

Mitigating measures would be the same as for the proposed action.

Any adverse effects which cannot be avoided should the alternate be implemented

The Telephone alternate would result in permanent disturbance of about 15 more acres of soil and vegetation than the proposed route. By improving access in a large area, the alternate could cause an increase in harassment of mule deer and desert tortoise, but impacts on wildlife caused by this alternate would be much less than those impacts resulting from the proposed route. Improved access could also result in losses of archaeological and historical values, especially in the ~~are~~area near Beaver Dam Wash.

Blake's Lambing Ground alternate

Description of alternate action

The Blake's Lambing Ground alternate (Illustrations VIII-25 and VIII-26) would leave the proposed route east of the Beaver Dam Mountains, cross Blake's Lambing Ground for 3.6 miles and then rejoin the proposed route. This alternate would be about 265 miles in length.

Description of the environment

The Blake's Lambing Ground alternate would avoid crucial Gambel's quail habitat and prime Gila monster habitat in Cedar Wash. In all other respects the alternate is similar to the proposed route.

Environmental impacts of alternate action

Impacts resulting from the Blake's Lambing Ground alternate would be similar to the proposed route except the alternate would not cross the crucial quail and Gila monster habitat described above.

Mitigating measures

Mitigating measures would be the same as the proposed action.

Any adverse effects which cannot be avoided should the alternate be implemented

Adverse effects along the Blake's Lambing Ground alternate would be the same as environmental impacts described above.

California Wash alternate

Description of alternate action

The California Wash alternate (Illustrations VIII-28 and VIII-29) would follow the proposed route for 192 miles to an angle point northeast of Glendale, Nevada. From here, the alternate would continue southwest for 3.5 miles, cross

Interstate 15 about 1 mile east of Glendale, and then cross the Muddy River to high ground on the south side of the river. The route would continue southwest to the Arizona Strip alternate and follow this alternate for 2.5 miles. The California Wash alternate would then turn southwest for about 22 miles, leaving Interstate 15 and following a buried Atlantic Telephone and Telegraph telephone cable. The alternate would then rejoin the proposed Kaiparowits to Eldorado route east of the Dry Lake Range. This alternate would be 262 miles long.

Description of the environment

The environment is nearly the same along California Wash as along the proposed route with the exception of archaeological values. The same general types of sites and artifacts have been found along both routes; however, it is likely that a denser concentration of sites and artifacts would occur along the alternate.

Environmental impacts of alternate action

The California Wash alternate could result in greater impacts on archaeological values than the proposed route because of the likelihood of a denser concentration of sites along California Wash. The alternate would follow a right-of-way for a buried telephone cable which could provide access to the alternate. The alternate would create a new transmission line corridor that would result in reduced visual quality for about 10 miles along I-15. The proposed route would follow an existing transmission line corridor west of I-15 for a similar distance.

Mitigating measures

Same as the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Unmitigated impacts would be the potential loss of archaeological data along California Wash and the visual impacts caused by a new transmission line corridor a few miles east of I-15.

Lava Butte alternate

Description of alternate action

The Lava Butte alternate (Illustrations VIII-29 and VIII-30) would follow the proposed route for about 239 miles and would then angle due south for about 2 miles along the east slope of Lava Butte. It would then turn southwest for approximately 1 mile and rejoin the proposed route on the north side of Las Vegas Wash. This alternate would be 269 miles long.

Description of the environment

The area along the east slope of Lava Butte is an undisturbed area with relatively high natural values. The alternate route would be adjacent to the west boundary of the Lake Mead Recreation Area.

Environmental impacts of alternate action

The Lava Butte alternate would result in a higher impact on scenic and natural values than would the proposed route. Although the proposed route would reduce scenic quality as viewed from the Rainbow Gardens Area, existing lines have already reduced scenic quality as viewed from this area. The alternate would constitute 3 miles of new intrusion visible from Las Vegas Beach on Lake Mead.

Mitigating measures

Mitigating measures are the same as those for the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Lava Butte alternate would reduce scenic and natural values of 3 miles of undisturbed land along the east side of Lava Butte. This area would be visible from Las Vegas Beach on Lake Mead.

Railroad Pass alternate

Description of alternate action

The Railroad Pass alternate (Illustration VIII-30) would follow the proposed route for 247 miles to the outskirts of the city of Henderson at the base of the River Mountains. From there the route would angle southwest from the proposed route for 2.6 miles and head up a draw in the foothills generally following an existing power line. The route would then bend south for 2.8 miles and cross a canyon area in the foothills. It would then turn west for about 0.5 mile and descend the River Mountains to the floor of Las Vegas Valley 0.5 mile north of Railroad Pass. The alternate would turn southwest for about 4 miles through Railroad Pass and would cross Highway 93, the Union Pacific Railroad, a pipe line, and a transmission line, all of which cross the pass. The alternate would continue southwest along the foot of the Black Hills for 3 miles and then turn south for 2.5 miles across Eldorado Valley. At this point the alternate would turn southwest paralleling the Southern California Edison (SCE) north and south Boulder transmission lines. The alternate would follow these lines for 5 miles and then rejoin the proposed route 2 miles from Eldorado substation. This alternate would be 269 miles long.

Description of the environment

The environment along the Railroad Pass alternate is about the same as along the proposed route with three exceptions. The alternate would cross about

12 more miles of undisturbed land and a desert bighorn sheep migration route. The proposed route would parallel the same migration route. A few miles north of Railroad Pass the alternate would pass through important winter habitat for bighorn sheep.

Environmental impacts of alternate action

The Railroad Pass alternate would restrict the migration of desert bighorn sheep much less than would the proposed route, since these animals have a greater tendency to cross rights-of-way such as roads, transmission lines, etc., at right angles rather than to migrate along them. However, north of Railroad Pass the alternate could prevent bighorn sheep from using part of their winter habitat in the River Mountains.

The alternate would create about 12 miles of new transmission corridor in Las Vegas and Eldorado valleys and it could eliminate part of Eldorado Valley as a potential site for an airport. The alternate would not be visible from Henderson as would the proposed route; however, the proposed route would not be an entirely new intrusion since it follows an existing line.

Mitigating measures

The mitigating measures would be the same as on the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Railroad Pass alternate could interfere with the migration of desert bighorn sheep, but not to the extent the proposed route would and it could prevent bighorn sheep from using part of their winter habitat in the River Mountains. The alternate could also eliminate part of Eldorado Valley as a potential site for an airport.

Black Hills alternate

Description of alternate action

The Black Hills alternate (Illustration VIII-30) would follow the proposed route to Railroad Pass southeast of Henderson, Nevada. At this point the alternate would turn south and follow the Railroad Pass alternate to Eldorado substation. The Black Hills alternate would be about 268 miles long.

Description of the environment

The environment along the Black Hills alternate is the same as the environment along the proposed route and the Railroad Pass alternate.

Environmental impacts of alternate action

The Black Hills alternate would combine some of the better features of the proposed route and the Railroad Pass alternate, while it would eliminate some of the more undesirable features of both. By following the proposed route to Railroad Pass, the alternate would have less impact than the Railroad Pass alternate on scenic and natural values and desert bighorn sheep in the River Mountains. The Black Hills alternate would be visible for a few miles east of Henderson; however, it would follow an existing line which has already reduced scenic quality. This alternate would not restrict the migration of desert bighorn sheep as much as the proposed route south of Railroad Pass or the Railroad alternate north of Railroad Pass.

The alternate would create about 7 miles of new corridor, about 5 miles less than the Railroad Pass alternate. The Black Hills alternate could eliminate part of Eldorado Valley as a potential site for an airport.

Mitigating measures

Mitigating measures would be the same as those for the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Black Hills alternate could interfere with normal migration of desert bighorn sheep, but not as much as the proposed route or the northern half of the Railroad alternate route. The alternate could eliminate part of Eldorado Valley as a potential site for an airport.

Kaiparowits to Eldorado Nos. 1 and 2 alternate

Description of alternate action

The Kaiparowits to Eldorado Nos. 1 and 2 alternate (Illustrations VIII-19 through VIII-25) would consist of two parallel 500 kV transmission lines from Kaiparowits to Eldorado and one such line from Eldorado to Mohave. The alternate would maintain a 2,000-foot separation where it follows existing lines from Kaiparowits to Eldorado. From Eldorado to Mohave it would maintain a 2,000-foot separation from existing lines for 6 miles and a 130-foot separation the rest of the way to the Mohave generating station.

This alternate would follow previously described alternate routes. Beginning at the plant site, it would follow, in order, the East Clark Bench alternate, the Northern Kaiparowits to Mohave alternate, the Arizona Strip alternate, the California Wash alternate, rejoin the Northern Kaiparowits to Mohave alternate, then follow the Lava Butte alternate, again rejoin the Northern Kaiparowits to Mohave alternate, and then follow the Railroad Pass alternate to Eldorado substation. From here the Kaiparowits to Eldorado Nos. 1 and 2 alternate would follow the Northern Kaiparowits to Mohave alternate to Mohave generating station. Since it is the alternate preferred by the participants, the Kaiparowits to Eldorado Nos. 1 and 2 alternate is described in further detail below.

From the Fourmile Bench generating station, this alternate would run southwest and south for 3.4 miles across the Fourmile Bench Plateau. Then the

alternate would turn southwest for about 4 miles along the plateau, drop into Smith Run, and then continue southwest across the canyon, rising to a low bench which separates Wahweap Creek from Smith Run.

Turning south for 1.5 miles, the alternate would drop off the low bench and cross to a high point on the west bank of Wahweap Creek. It would then proceed southwest for about 2 miles parallel to the creek channel along the base of Jack Riggs Bench. The alternate would then angle south for 1.4 miles to an angle point, and turn west for 8.6 miles crossing East Clark Bench, Cottonwood Canyon Road (a dirt road), and the Utah Power and Light 230 kV wood pole line.

Continuing west for about 5 miles, the alternate would cross the Paria River and then bend south for 5.2 miles along the toe of the Cockscomb, crossing Highway 89, Catstair Canyon, and the Garkane 69 kV transmission line to another angle point.

From the angle point, the alternate would proceed southwest for 2.4 miles and ascend the lower reaches of Fivemile Mountain on the south side of a small hogback near the LADWP Navajo-McCullough 500 kV transmission line. The alternate then would cross the LADWP line and proceed southwest parallel to the south side of the line, maintaining a 2,000-foot separation. The alternate would climb the northwest slopes of the Buckskin Mountains from an elevation of about 5,800 feet to about 6,300 feet. It then would proceed southwest for approximately 5 miles, descend the Buckskin Mountains, and cross from Kane County, Utah to Coconino County, Arizona. The alternate would continue southwest for 7.6 miles to an angle point. The next 18 miles of the alternate would generally be parallel to and about 3 miles southeast of Highway 89. At the angle point the alternate would turn west for 5.5 miles across a relatively level sagebrush plain to another angle point on the southeast side of Johnson Wash. The alternate then would turn southwest for 7 miles parallel to Johnson Wash, and cross Highway 89A and a

telephone line. It would continue southwest over relatively flat range land, crossing a graded dirt road (Ryan Road) to an angle point about 6 miles southeast of Fredonia, Arizona. The alternate would angle west for 6.1 miles, enter and cross 3.1 miles of the Kaibab Indian Reservation, and after 4.7 miles cross Kanab Creek which forms the boundary between Coconino and Mohave counties, Arizona. The alternate would then proceed due west for 7 miles through Pipe Valley (a broad shallow valley draining southeast into Kanab Creek) to the next angle point. This portion of the alternate would cross a graded dirt road (the Mount Trumbull Road) and pass about 4 miles south of Pipe Springs National Monument, which is in the Kaibab Indian Reservation.

Continuing west for 26.5 miles with a slight deflection to the south, the alternate would gradually climb out of Pipe Valley and cross the Uinkaret Plateau to the top of the Hurricane Cliffs. Portions of the alternate would generally parallel the old Navajo Trail Road about 3 miles to the north. The alternate would continue west for 7.5 miles, descend the Hurricane Cliffs where the Navajo Trail follows a draw through the cliffs, and then cross a wide valley west of the cliffs. The alternate would then angle northwest for 5.1 miles and cross a north-south ridge into Main Street Valley to another angle point at the base of Seegmuller Mountain. Then it would turn southwest for 20.2 miles, pass through relatively level terrain and then follow a pass through a mountainous area to Cottonwood Wash. The alternate would then proceed southwest for 5 miles and then northwest for 7.5 miles, following the wash through a narrow pass. Near the Virgin Mountains, the alternate would cross a plateau that rises about 400 feet above the surrounding terrain, and then angle west for 16.5 miles, passing through a saddle on the crest of the Virgin Mountains and descend the mountains. Between the mountains and the Virgin River, the alternate would cross about 3 miles south of Riverside, Nevada, and U.S. Highway 91.

After crossing the Virgin River the alternate would angle southwest for 18.8 miles, climb out of the Virgin River Valley, and cross the flat, sparsely vegetated Mormon Mesa. The alternate would then drop into Moapa Valley and cross State Highway 12 which provides access from Interstate 15 to the Lake Mead Recreation Area about 10 miles south of the alternate. The communities of Logandale and Overton, Nevada, are located on Highway 12 about 4 miles and 9 miles south of the alternate, respectively. The alternate would pass north of farm lands in the Logandale area and cross the Muddy River and a Union Pacific spur track. This portion of the alternate would be about 2 miles south of the small community of Glendale, Nevada, and Interstate 15. The alternate would continue southwest to within 0.5 mile of Interstate 15, angle south for approximately 2 miles and southwest for about 22 miles, diverging from Interstate 15 along a buried AT&T telephone cable.

The alternate would return to a position 2,000 feet from the LADWP Navajo-McCullough line near Apex, Nevada. From here it would continue southwest across hilly desert terrain and then cross a broad area sloping south to Lake Mead. After approximately 2 miles, the alternate would angle west and pass about 0.5 mile west of a gypsum mining operation. It then would cross a gas pipe line, a railroad spur track, a paved road, and a wood pole power line, all leading to the gypsum plant. The alternate would continue southwest for 4.9 miles, crossing the east portion of the proposed Sunrise Mountain Natural Area and within 500 feet of the west border of the Lake Mead Recreation Area. This portion of the alternate would be about 3 or 4 miles northwest of the shore of Lake Mead.

The alternate would then angle due south for about 3 miles, pass along the east slope of Lava Butte, turn southwest for approximately 1 mile, and then turn south down a canyon into the Las Vegas Valley. In Las Vegas Valley the alternate would cross Las Vegas Wash and State Highway 41, an access road to the

Lake Mead National Recreation Area. After crossing Highway 41, the alternate would continue south for 6.5 miles along the east edge of the valley, crossing several wood pole and steel tower transmission lines and a wood pole telephone line. The alternate would angle southwest for 2.6 miles heading up a draw in the River Mountains. The alternate would then bend south for about 2.8 miles, cross a canyon area, and then turn west for about 0.5 mile, descending the River Mountains to the floor of Las Vegas Valley 0.5 mile north of Railroad Pass.

The alternate then would turn southwest for approximately 4 miles through Railroad Pass and cross U.S. Highway 93, the Union Pacific Railroad, a pipe line and a transmission line all of which use the pass for access between Las Vegas and Eldorado valleys. The alternate would continue southwest into Eldorado Valley along the east edge of the McCullough Range, and then turn due south for about 3 miles. The alternate would cross and then parallel the SCE north and south Boulder transmission lines southwest for approximately 5 miles and then angle south to Eldorado substation. This segment of the alternate - Kaiparowits to Eldorado - would be 248 miles long.

The remainder of this alternate would consist of a single 500 kV transmission line from Eldorado substation to Mohave generating station. This portion of the alternate would follow the proposed route of the Northern Kaiparowits to Mohave alternate and would be about 57 miles long; the total length of the alternate would be 305 miles.

Description of the environment

The Kaiparowits to Eldorado Nos. 1 and 2 alternate would follow existing lines on a 2,000-foot separation along the following segments: (1) from the Cockscomb near the plant site to a point 18 miles southwest of Fredonia, Arizona; (2) from a point 15 miles east of Apex, Nevada, to the north end of Lava Butte;

(3) from the south end of Lava Butte to a point 2 miles northwest of Henderson, Nevada; and (4) past Eldorado substation for 6 miles. The alternate would follow a total of 72 miles of existing line on a 2,000-foot separation and 52 miles of existing line on a 130-foot separation. The remaining 181 miles of the alternate would cross areas with no transmission lines nearby.

For further descriptions of the environment along this alternate, refer to appropriate sections of the East Clark Bench, Northern Kaiparowits, Arizona Strip, California Wash, Lava Butte, and Railroad Pass alternates.

Environmental impacts of alternate action

Environmental impacts resulting from the Kaiparowits to Eldorado Nos. 1 and 2 alternate would be the same as those described for the alternates that it would follow.

Mitigating measures

Same as the proposed Kaiparowits to Eldorado route and pertinent alternates.

Any adverse effects which cannot be avoided should the alternate be implemented

Environmental impacts resulting from the Kaiparowits to Eldorado Nos. 1 and 2 alternate would be the same as those described for the alternates that it would follow.

Impact evaluation

An impact evaluation of all alternate transmission system routes for the Kaiparowits to Eldorado segment is contained in Figure VIII-10.

FIGURE VIII-10

Impact Evaluation of Alternate Routes for Proposed Kaiparowits to Eldorado Route[a]

		Importance to decision making[b]	Fivemile Valley	Cottonwood-Paria	East Clark Bench	Flat Top	Mokiah Wash	Black Rock Gulch	Navajo-McCullough	Highway 91	Telephone	Blake's Lambing Ground	California Wash	Lava Butte	Railroad Pass	Black Hills	Kaiparowits to Mohave Nos. 1 & 2
Mileage (more or less than proposed route)		5	+1	+1	+1	+9	-7	-2	-2	+2	+7	-4	-7	0	0	-1	+22
Climate		0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
Air Quality		1	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
Geology and Topography	General	1	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
	Seismology	0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
	Economic geology	0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
Soils	Erosion hazard	5	MM	MM	MH	MS	MM	MM	SS	SM	MH	MM	SS	NN	NN	NN	MH
	Rehabilitation potential[c]	5	SS	SS	MS	SM	MM	MM	MM	MS	MM	MM	SS	SS	SS	SS	MS
Water Resources	Quality	5	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
	Demand	7	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	4	SS	SS	SS	SS	SM	SM	NN	SM	SM	SS	NN	NN	NN	NN	MH
	Acres disturbed (permanent)	6	MM	MS	MM	MM	MH	MH	MS	SM	SM	MM	MM	SS	SS	SS	MH
	Acres disturbed (temporary)	6	MM	MS	MM	MM	MH	MH	MS	SM	SM	MM	MM	SS	SS	SS	MH
Wildlife	Terrestrial	9	MM	SS	MH	MS	MH	MH	HS	HS	HS	HS	HH	SS	HS	HS	MH
	Aquatic	2	NN	NN	NN	NN	SS	SS	NN	NN	NN	SS	MM	NN	SS	SS	SS
Ecological Interrelationships	Terrestrial	9	MM	SS	MH	MS	MH	MH	HS	HS	HS	HS	HH	SS	HS	HS	MH
	Aquatic	2	NN	NN	NN	NN	SS	SS	NN	NN	NN	SS	MM	NN	SS	SS	SS
Paleontology		2	SS	SS	SS	SS	SS	SS	NN	SS	SS	NN	SS	SS	SS	SS	SS
Archaeology		8	MM	MM	MM	MM	MH	MH	NN	SS	SM	NN	SM	MM	SS	SS	SM
History		6	SS	SS	SS	SS	MH	MH	NN	SS	SM	NN	SS	SS	SS	SS	SS
Recreation	General	6	MM	MM	SS	MM	MH	MH	SS	SS	SS	MM	SS	MM	SS	SS	MM
	Scenic values	10	MH	MH	HM	MS	MH	MH	MM	MM	MS	HH	MH	SM	SM	SS	SH
	Natural values	9	MM	MM	MM	MM	MH	MH	MM	MM	SS	MM	MM	SM	SM	SS	SH
Land Uses	Miles of new corridor (more or less than prop.)	9	-5	-6	0	+9	+78	+86	-12	+9	+39	0	+28	+3	+12	+7	+137
	Wood Products	1	SS	NN	SS	SS	SM	SM	NN	NN	NN	NN	NN	NN	NN	NN	NN
	Agriculture	1	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
Socio-Economic	Housing and services	1	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MH	MH	MH
	Culture and attitudes	1	SS	SS	SS	SSc	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS	SS

[a]Impacts rates as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The Second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

[c]This rating is not a comparison of impacts, but instead it is a comparison of rehabilitation potentials.

Kaiparowits to Phoenix

The proposed Kaiparowits to Phoenix alternate routes are shown in Illustrations VIII-33 through VIII-56.

John Henry alternate

Description of alternate action

The John Henry alternate (Illustrations VIII-34 and VIII-35) would follow the proposed route for 5.2 miles, and then turn southeast for 2.3 miles. From there it would run along a finger of Fourmile Bench for 2.5 miles, and down a ridge into John Henry Canyon. The route would then leave John Henry Canyon in a southerly direction for 2.2 miles and then head southwest for about 3.6 miles. It would continue south across Nipple Bench for 1.1 miles to the Nipple Creek area. Nipple Butte, a prominent sandstone formation, lies 0.75 mile west of the alternate route. The route would then follow Nipple Creek south for about 1 mile where it would turn southwest for 2.3 miles toward the Wahweap Creek Basin. After crossing Wahweap Creek, the route would continue south for about 2 miles to rejoin the proposed route just south of U.S. Highway 89. This alternate would then follow the proposed route to the Westwing substation (302 miles).

The John Henry alternate route would be 3 miles longer than the proposed route.

Description of the environment

The environmental conditions along the John Henry alternate are similar to those of the proposal.

Environmental impacts of alternate action

Environmental impacts for the John Henry alternate would be similar to those of the proposal; however, an additional 28 acres of surface disturbance would occur. This alternate would avoid a geologically unique erosional area of pinnacles and balanced rocks along the proposed route.

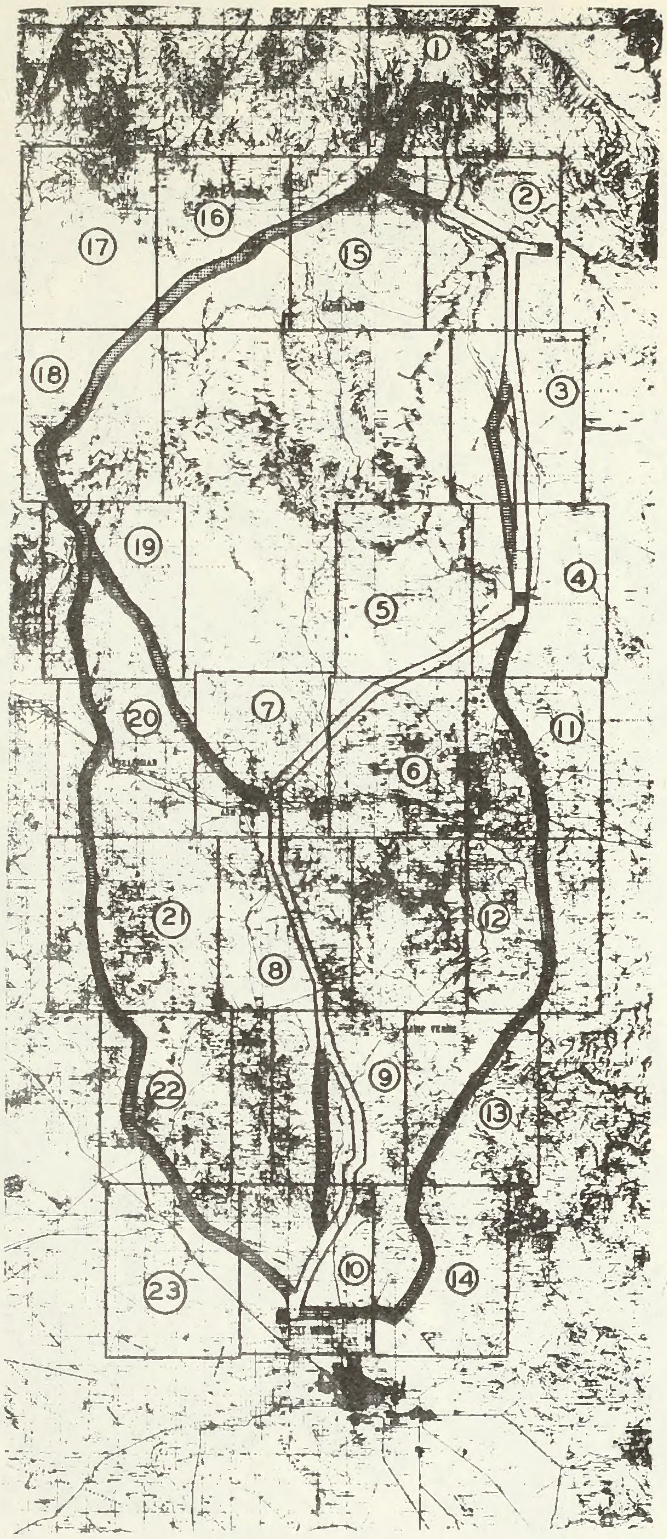

ILLUSTRATION VIII-33

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Index Sheet)

ILLUSTRATION VIII-34

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 1 of 23)

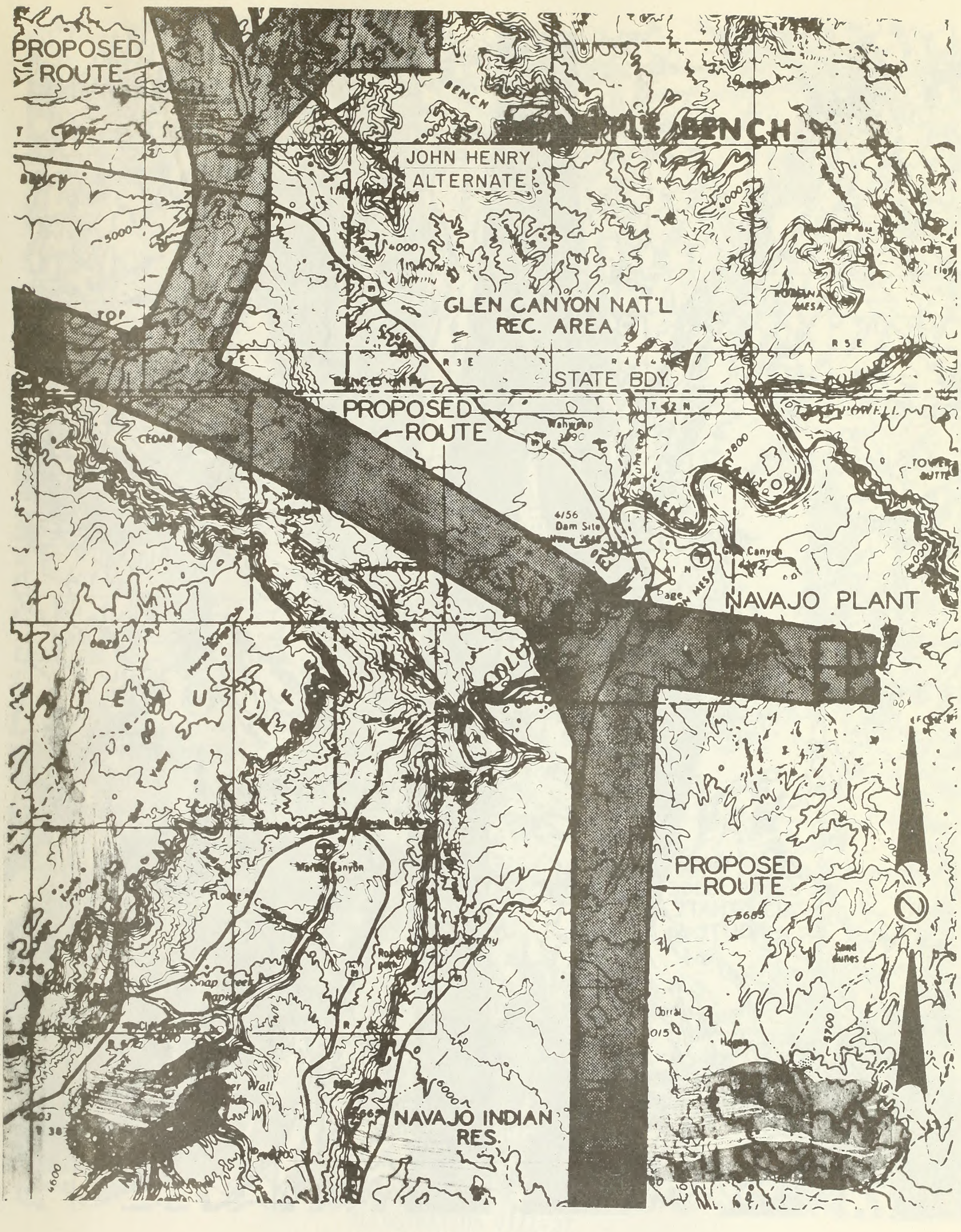

ILLUSTRATION VIII-35

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 2 of 23)

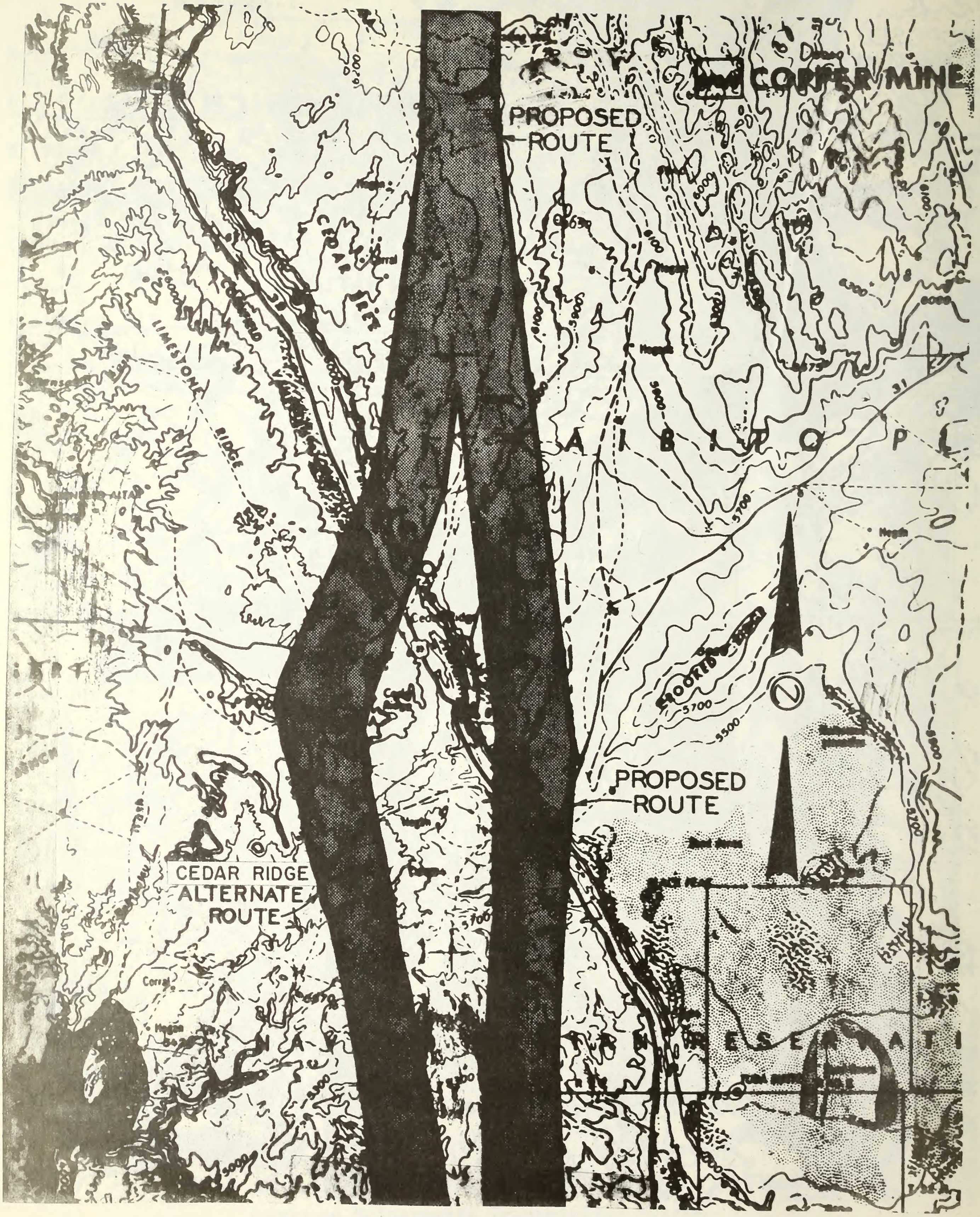

ILLUSTRATION VIII-36

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 3 of 23)

ILLUSTRATION VIII-37

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 4 of 23)

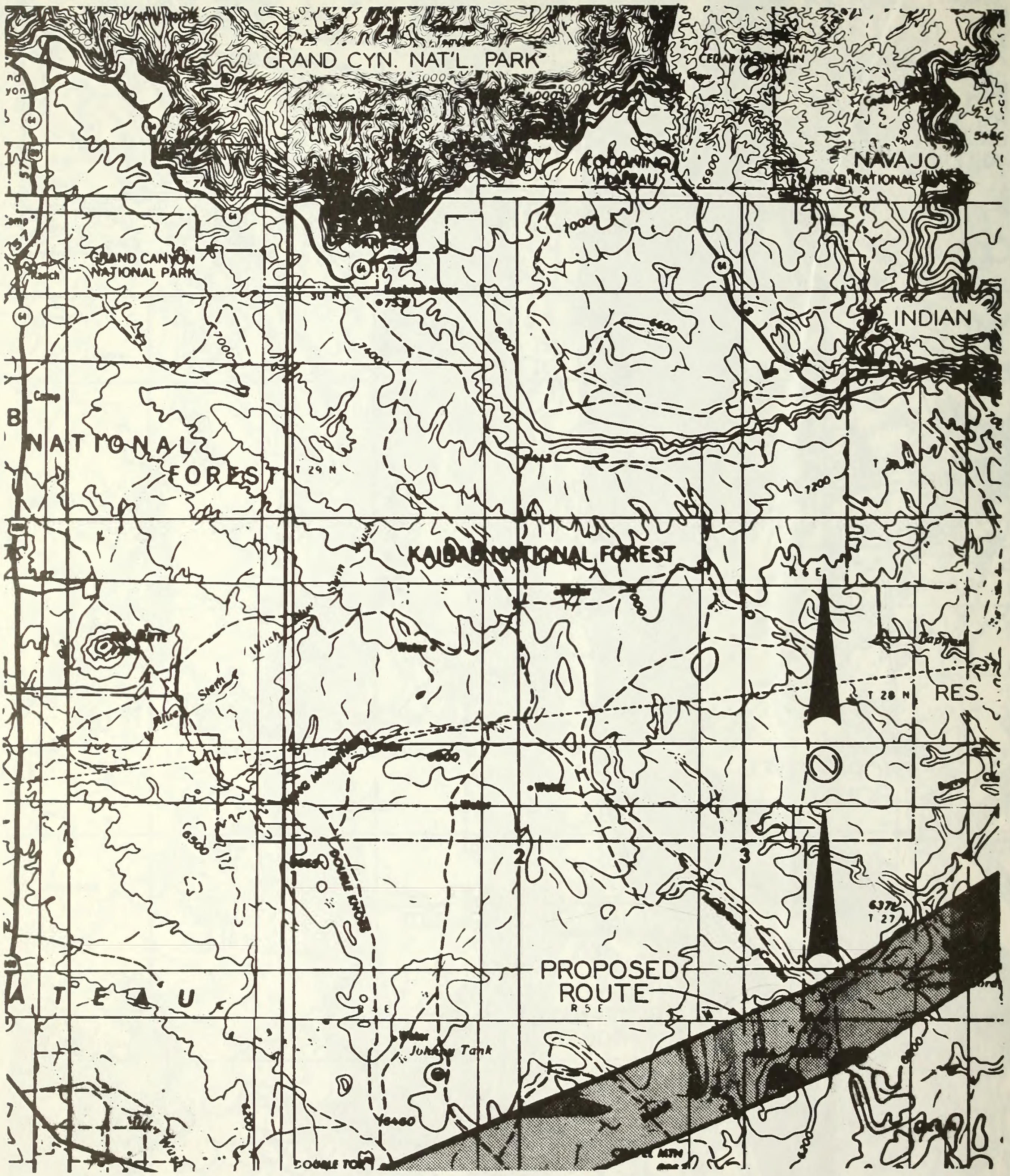

ILLUSTRATION VIII-38

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 5 of 23)

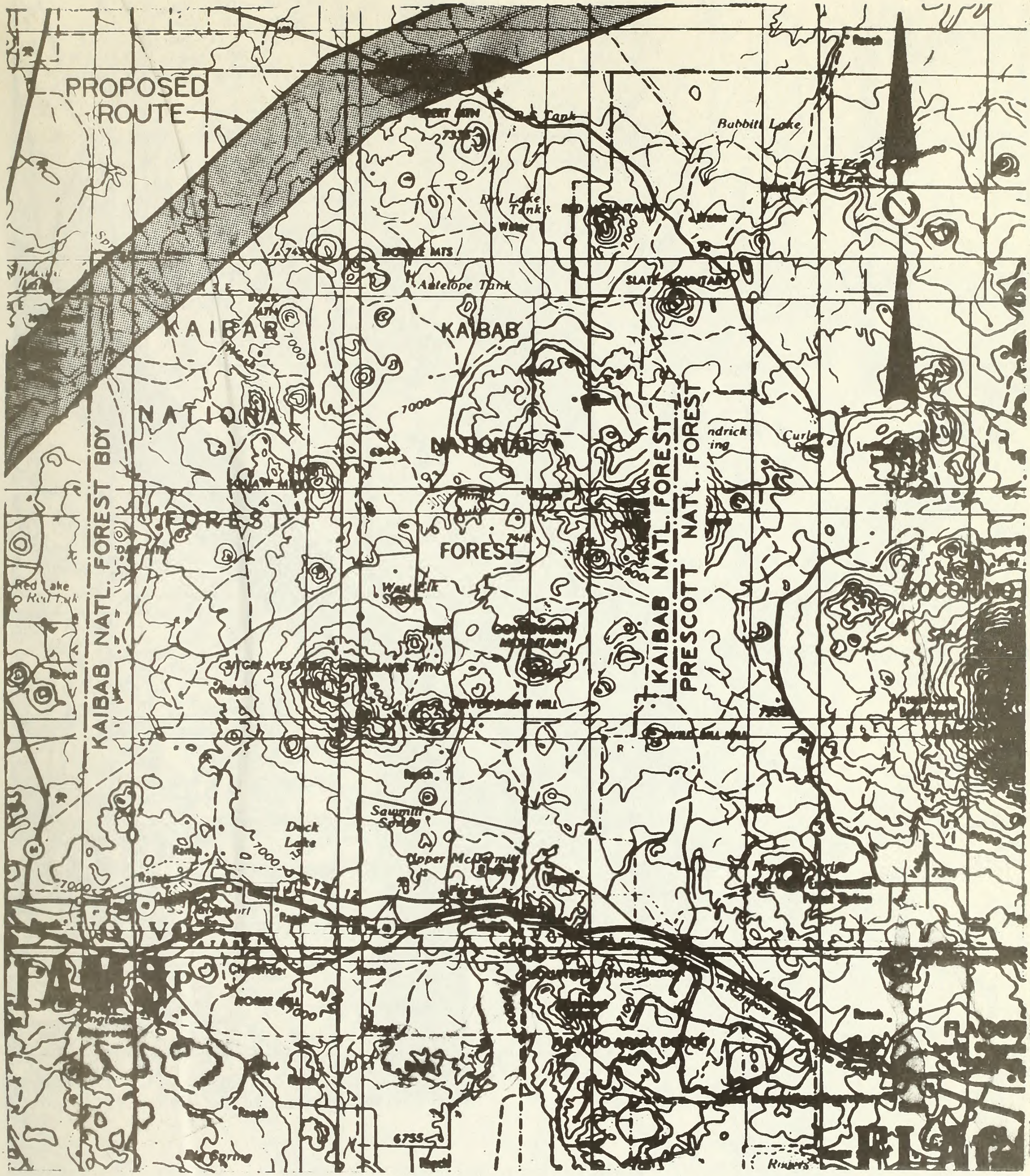

ILLUSTRATION VIII-39

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 6 of 23)

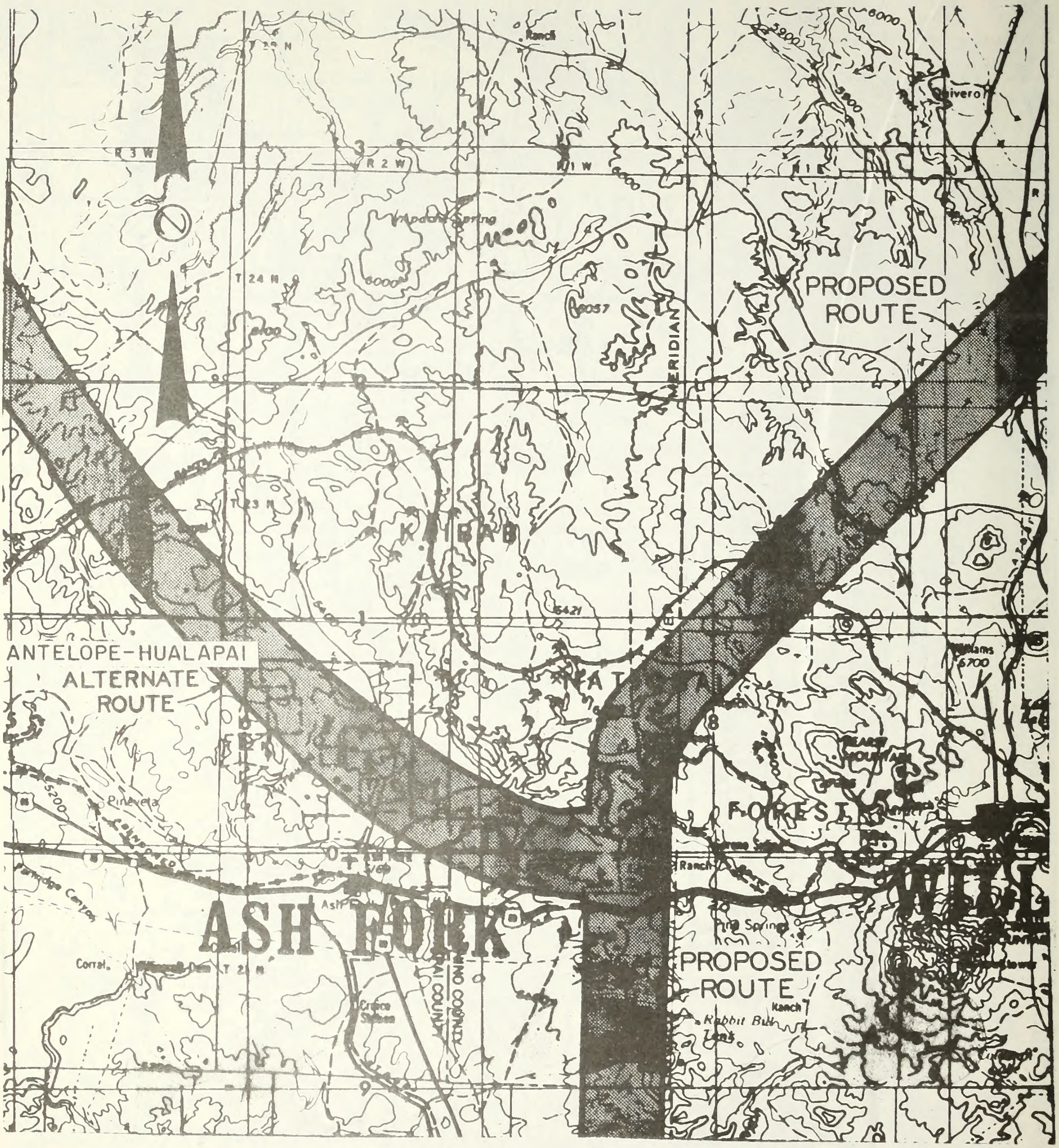

ILLUSTRATION VIII-40

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 7 of 23)

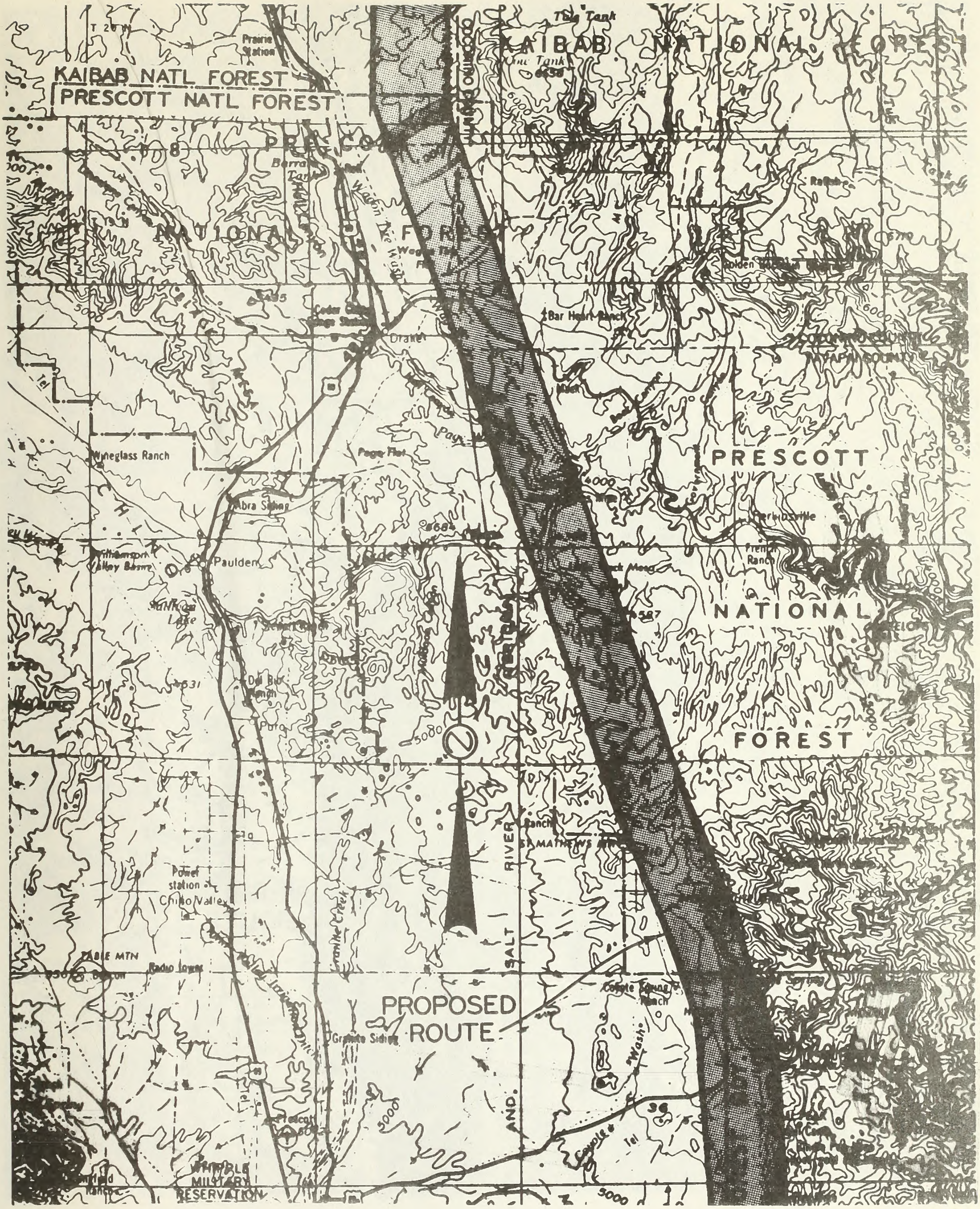

ILLUSTRATION VIII-41

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
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ILLUSTRATION VIII-42

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 9 of 23)

ILLUSTRATION VIII-43

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 10 of 23)

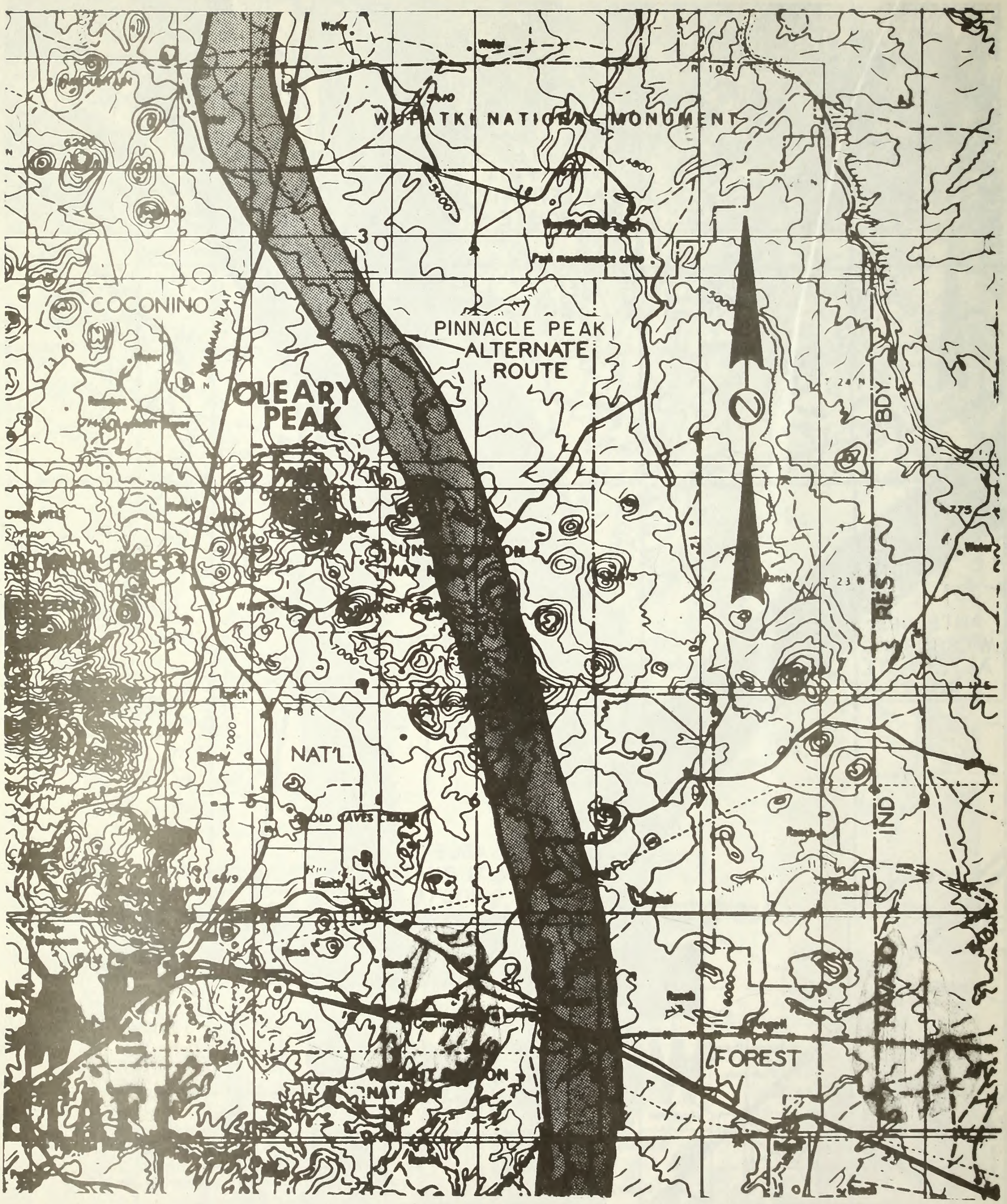

ILLUSTRATION VIII-44

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 11 of 23)

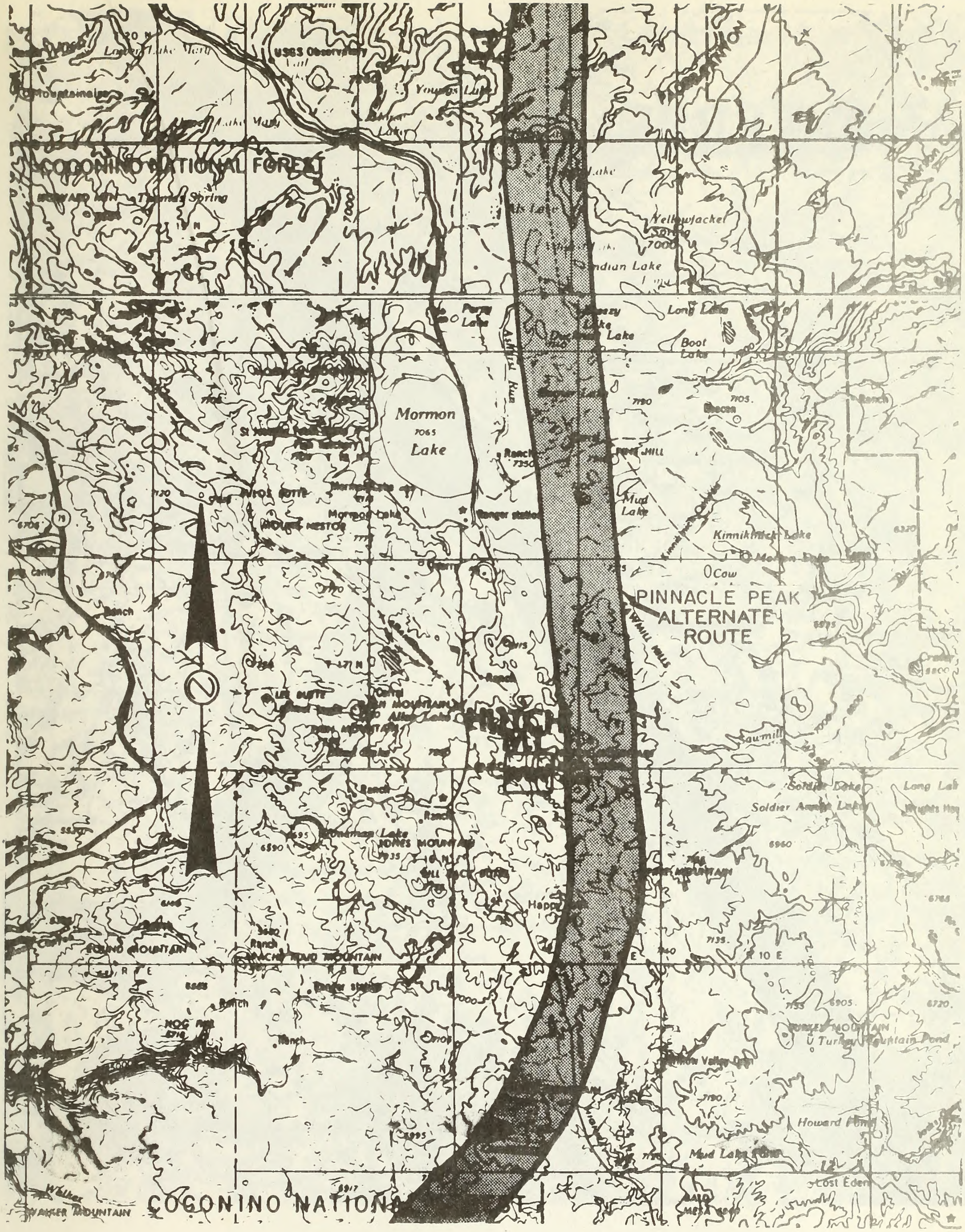

ILLUSTRATION VIII-45
Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 12 of 23)

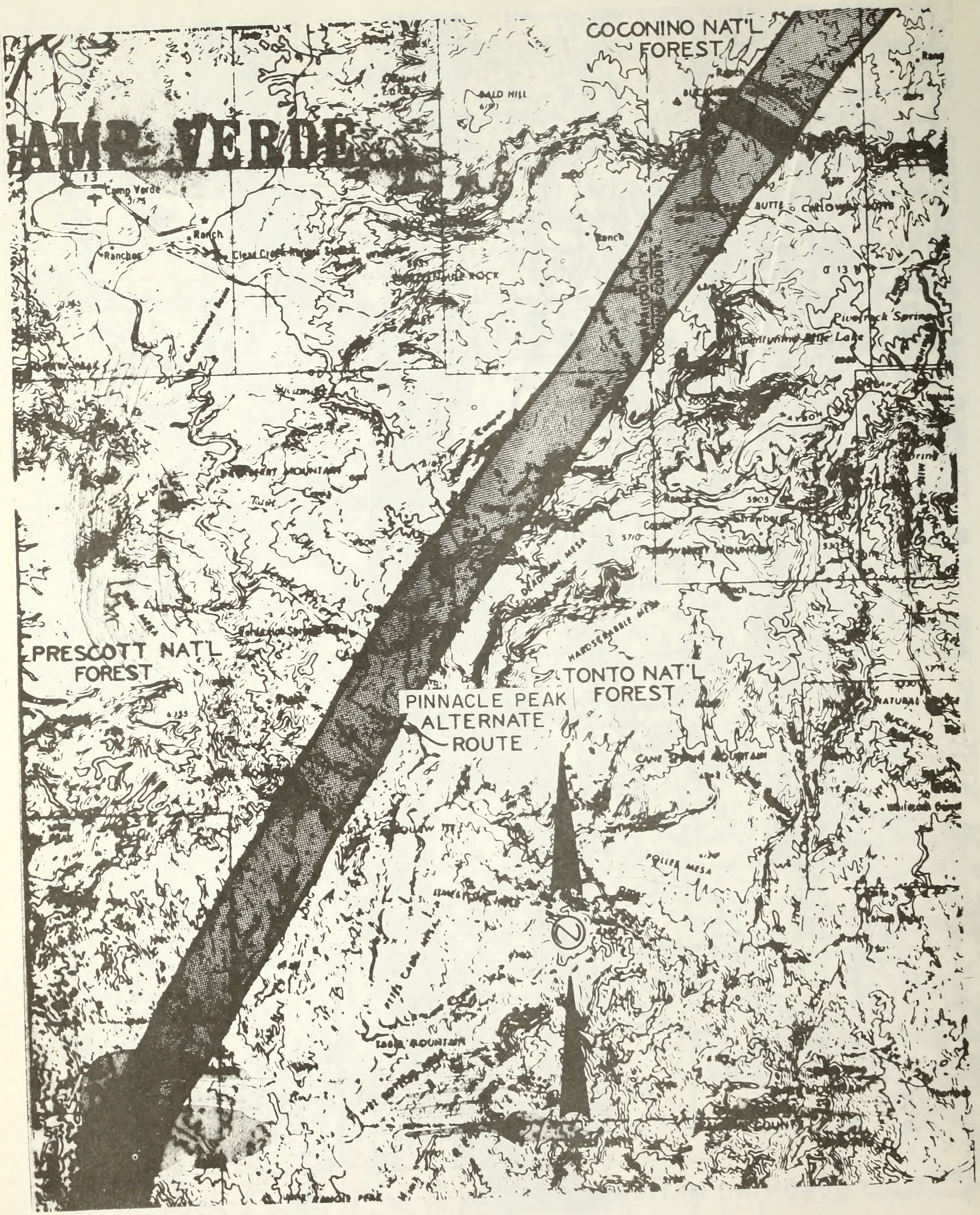

ILLUSTRATION VIII-46

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 13 of 23)

ILLUSTRATION VIII-47

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 14 of 23)

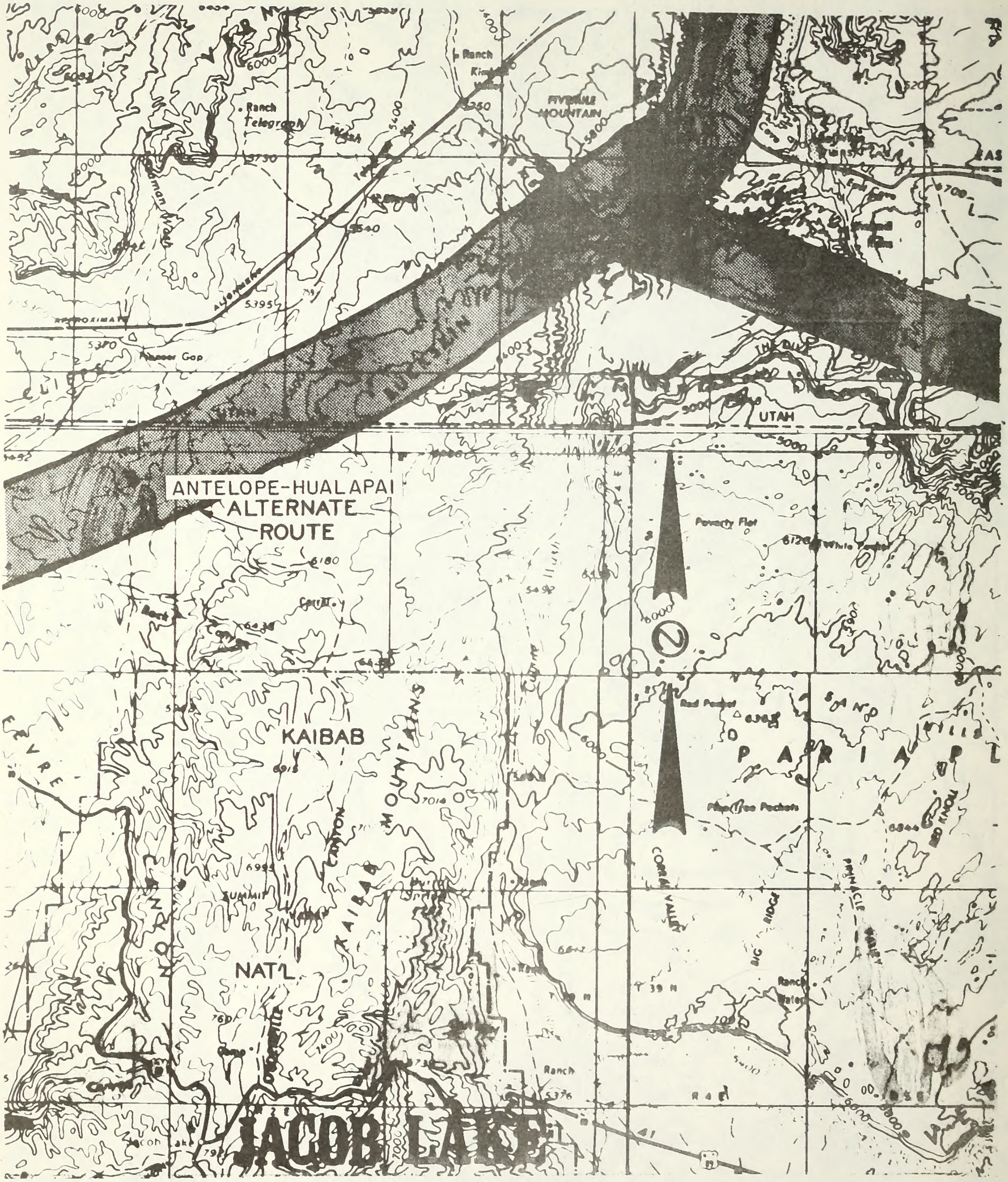

ILLUSTRATION VIII-48

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 15 of 23)

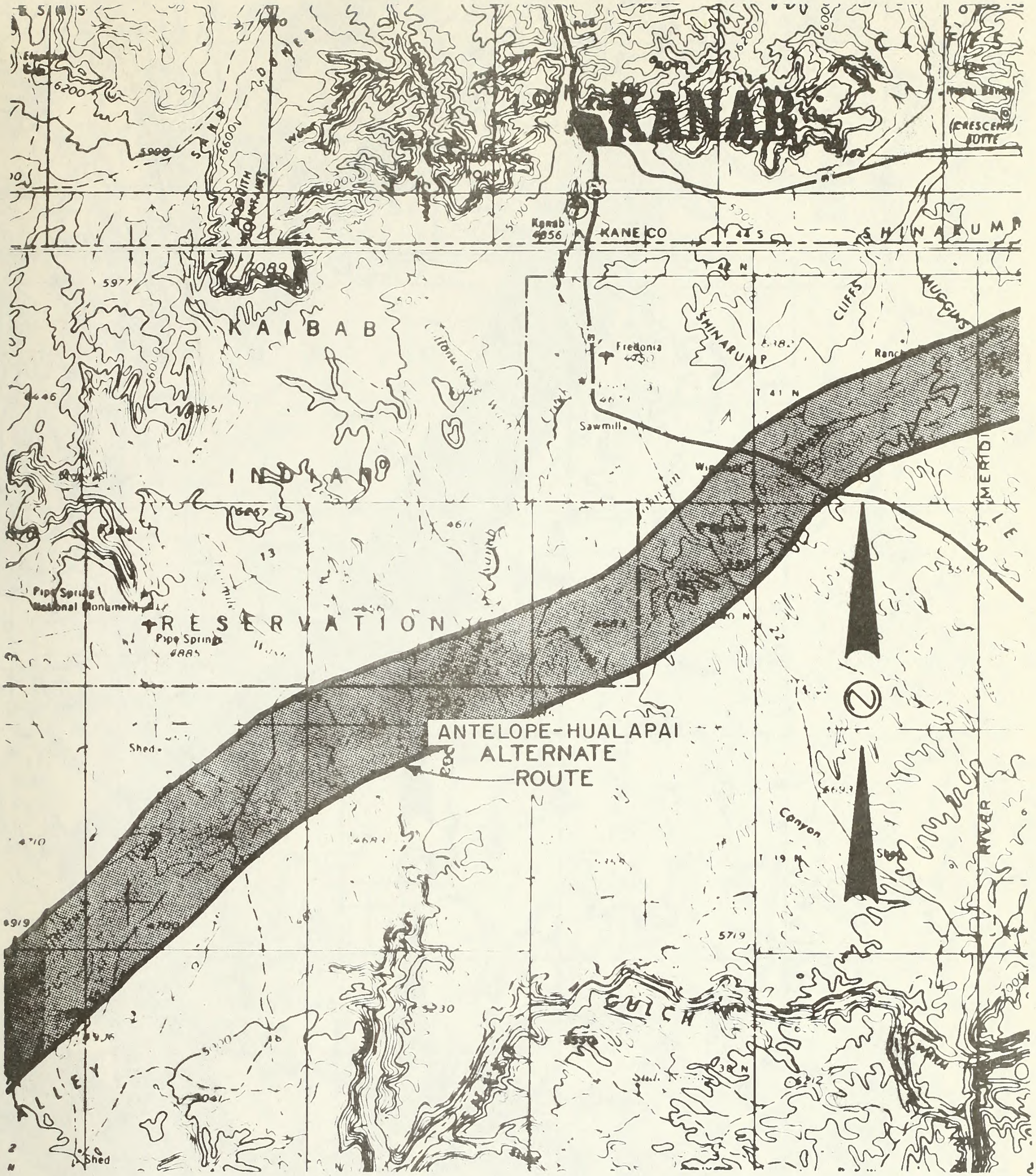

ILLUSTRATION VIII-49

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 16 of 23)

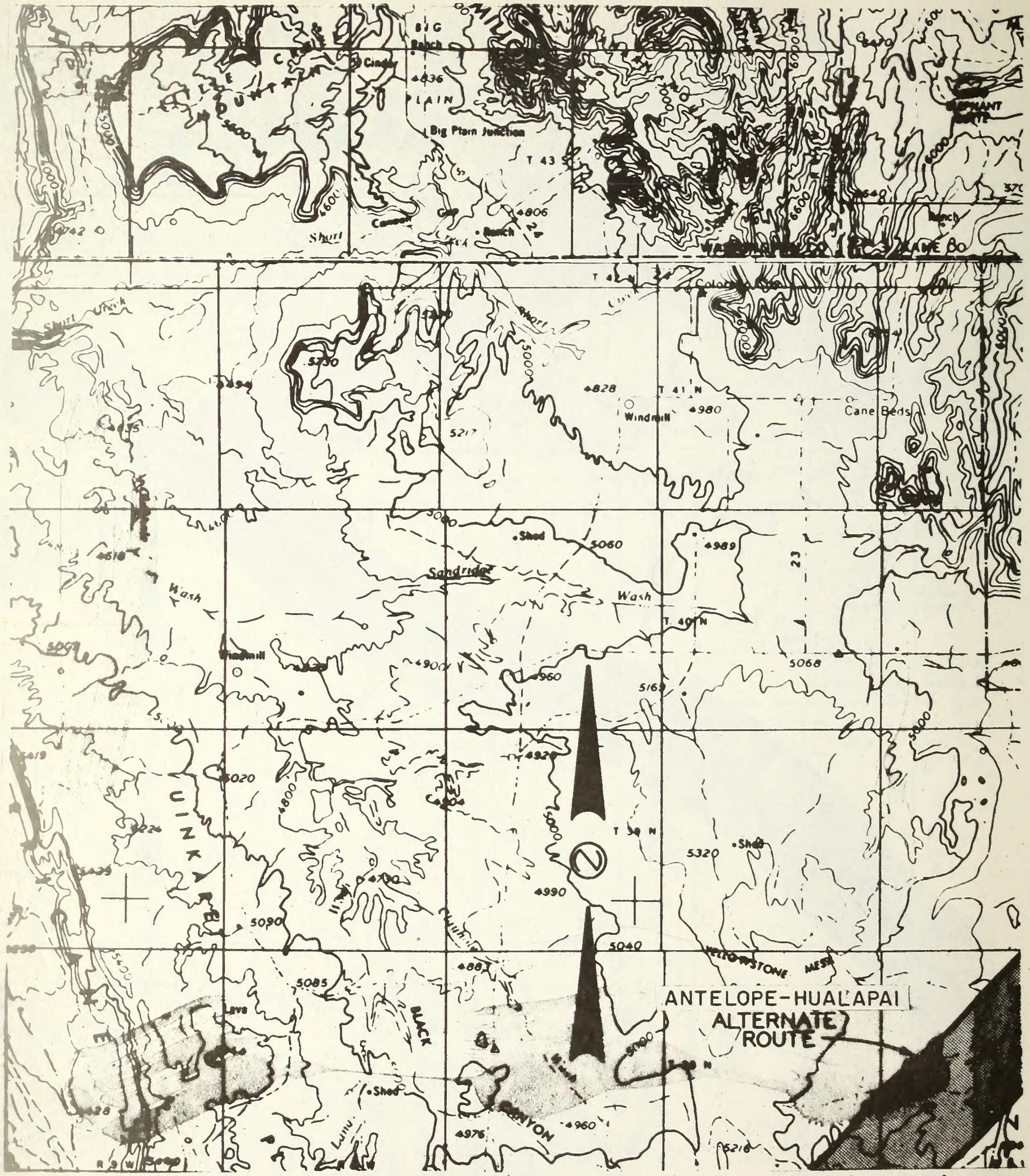

ILLUSTRATION VIII-50

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 17 of 23)

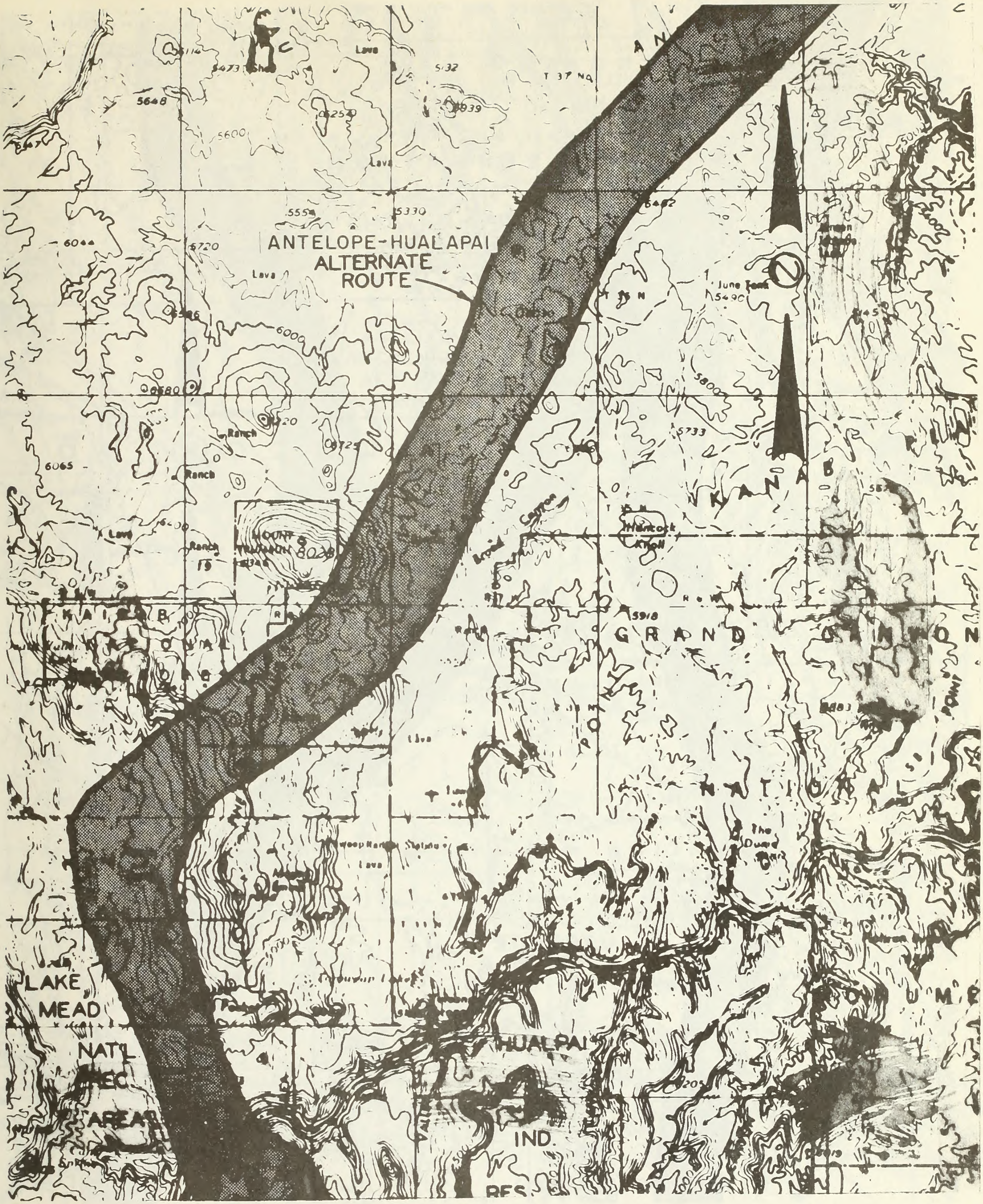

ILLUSTRATION VIII-51

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 18 of 23)

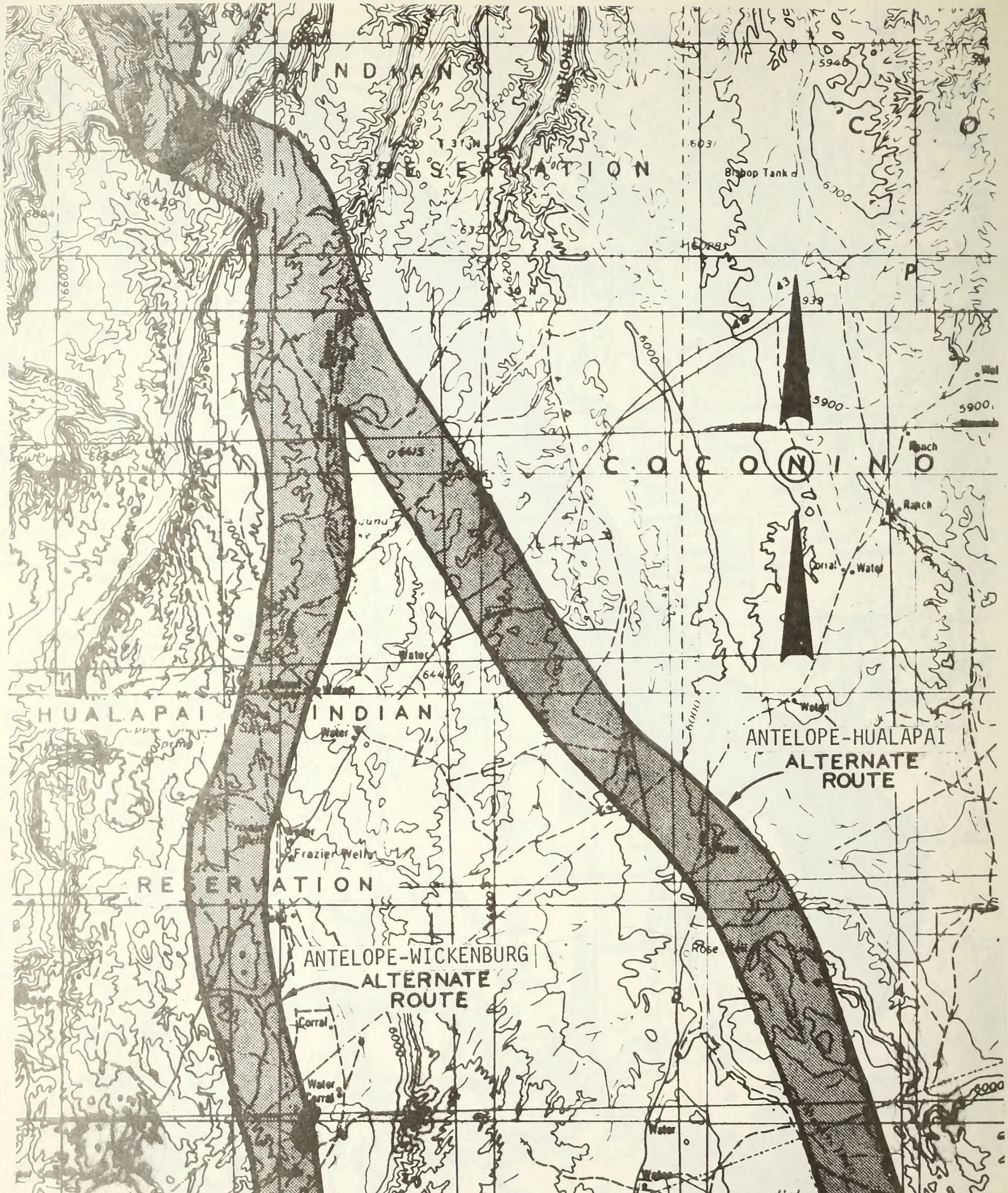

ILLUSTRATION VIII-52

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 19 of 23)

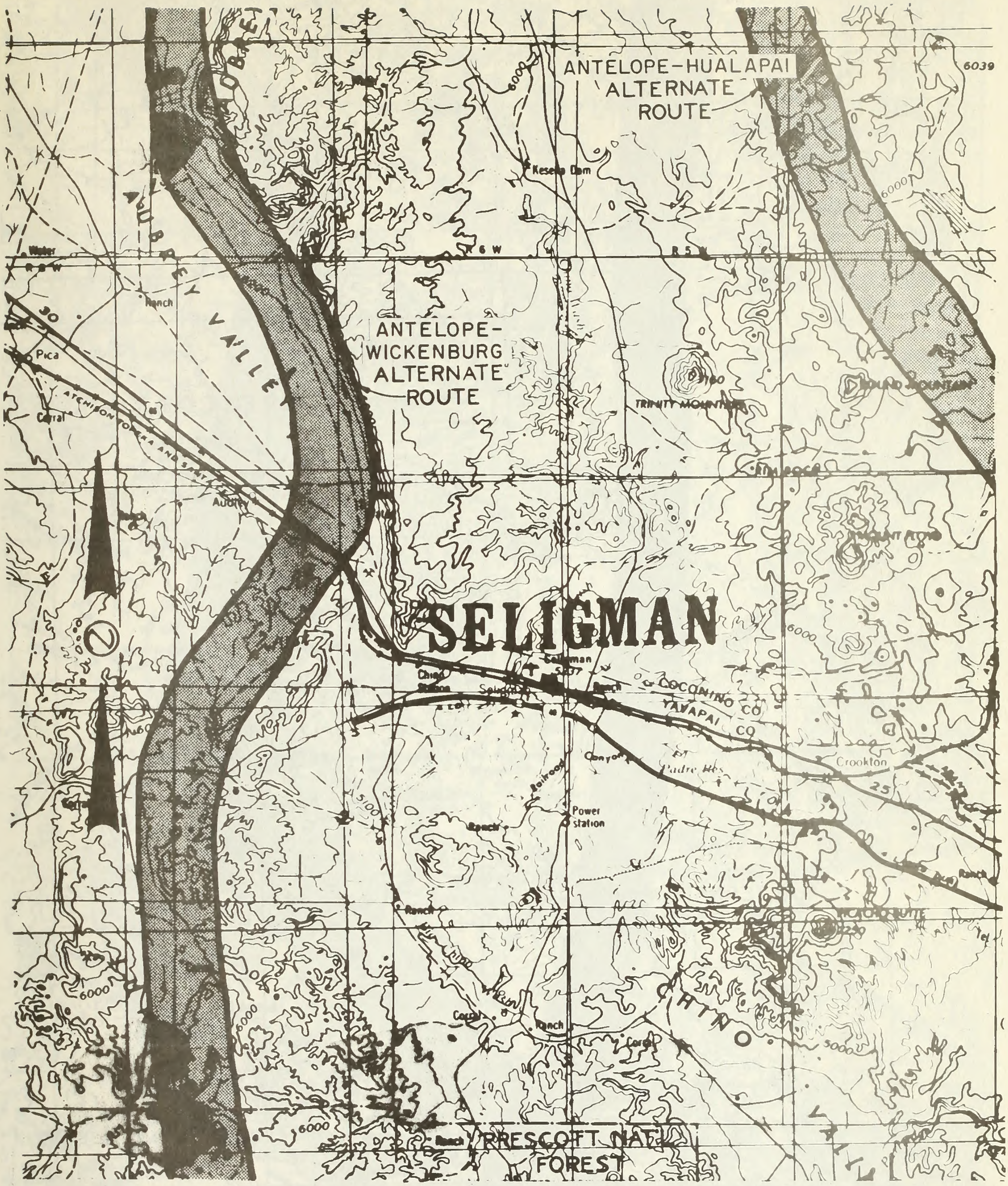

ILLUSTRATION VIII-53

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 20 of 23)

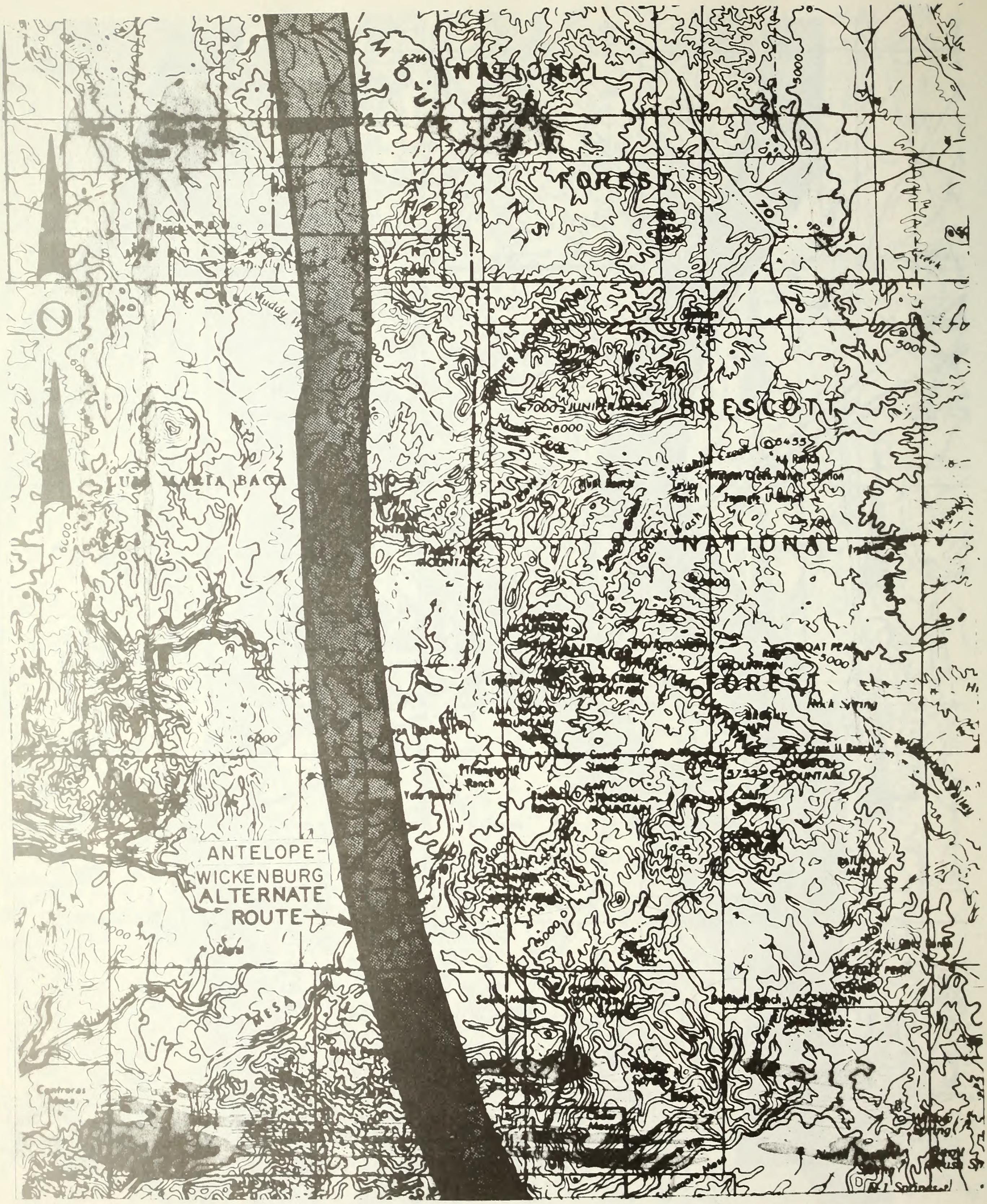

ILLUSTRATION VIII-54

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 21 of 23)

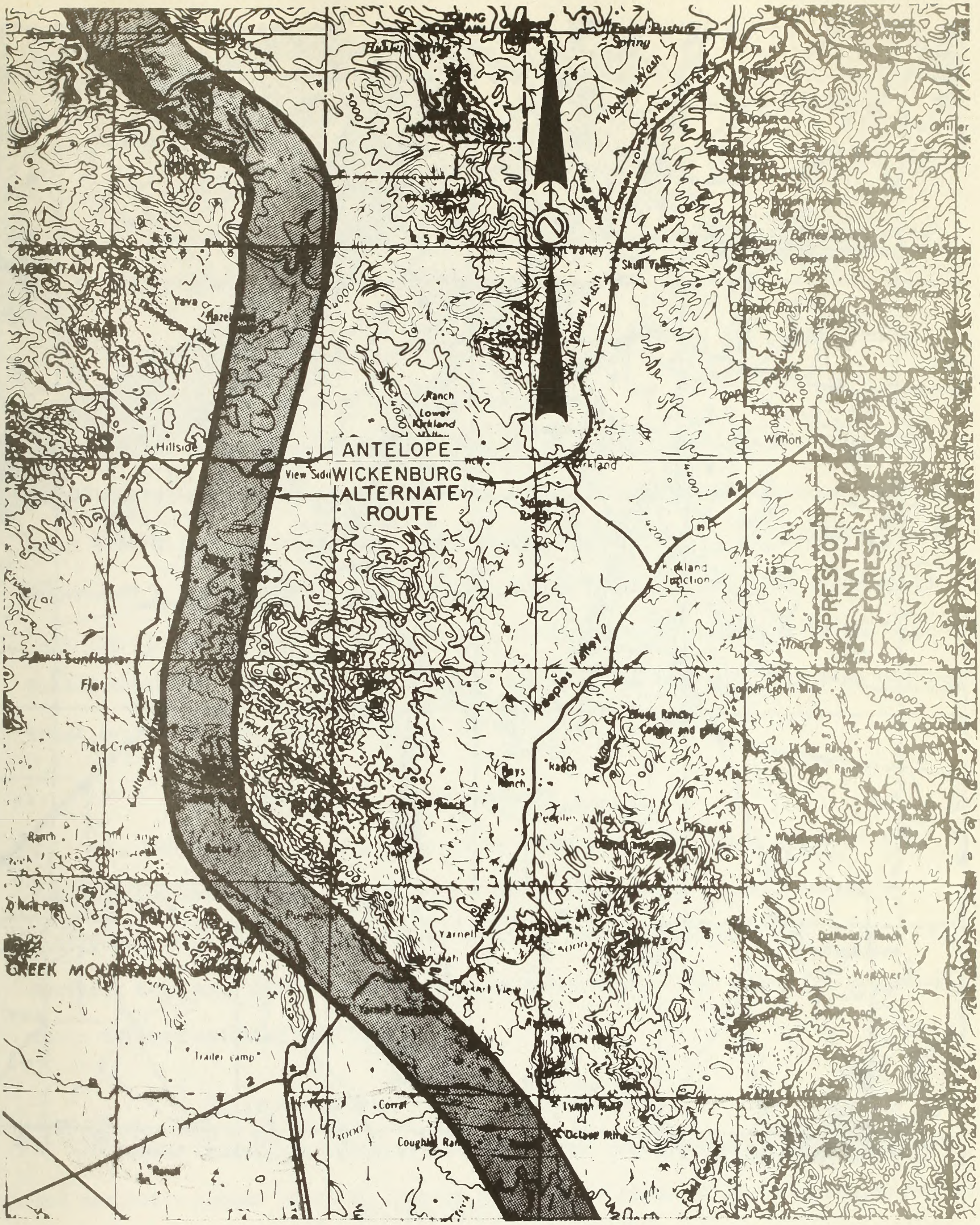

ILLUSTRATION VIII-55

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 22 of 23)

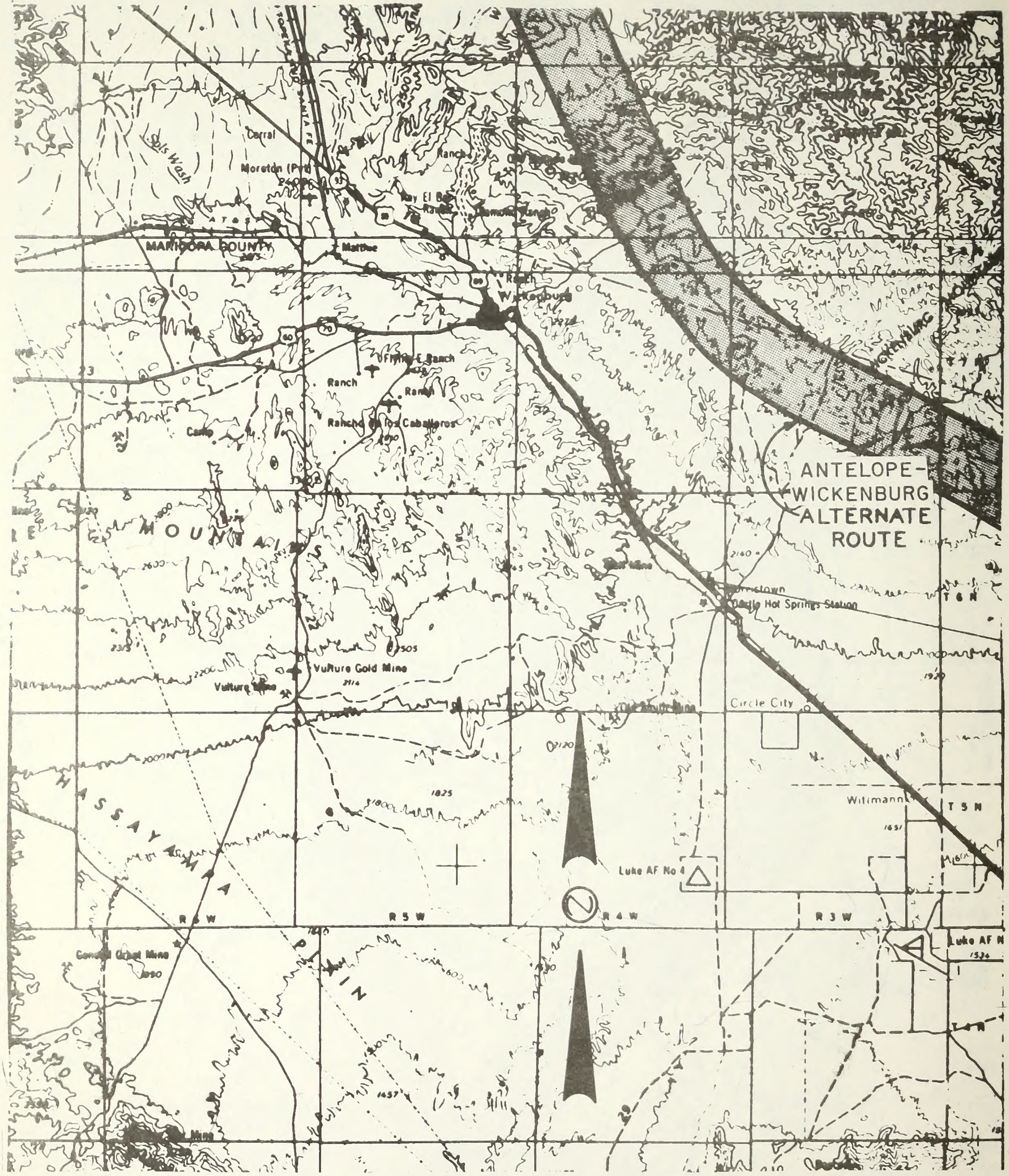

ILLUSTRATION VIII-56

Proposed Kaiparowits Transmission System
Kaiparowits to Phoenix Alternate Routes
(Sheet 23 of 23)

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

An additional 28 acres of surface disturbance would be the only additional effect that cannot be avoided.

Cedar Ridge alternate

Description of alternate action

The Cedar Ridge alternate (Illustrations VIII-36 and VIII-37) would follow the proposed route for 68 miles and then diverge south-southwest over the Cedar Tree Hills. The alternate would then descend the Echo Cliffs and cross Highway 89 a few miles north of the Cedar Ridge Trading Post. The route would then proceed to the east of Bodaway Mesa, continue south-southeast to the west of Shadow Mountain, and rejoin the proposed route at the Moenkopi switching station. Total length of this alternate would be 301 miles.

Description of the environment

The Cedar Ridge alternate route would cross 12.4 more miles of area rated medium archaeological sensitivity and 7 fewer miles of area rated low sensitivity than the proposed route. Ratings were determined by the Museum of Northern Arizona. This alternate crosses undisturbed lands while the proposed route follows existing corridor.

Environmental impacts of alternate action

The Cedar Ridge alternate would create a significant visual intrusion and aesthetic impact where it crosses Echo Cliffs since it would be highly visible from U.S. Highway 89 for several miles in both directions. It would also intrude

upon 68 miles of virtually undisturbed colorful desert landscape and disturb an additional 224 acres of soil and vegetation with required roads.

Impacts to the archaeological, paleontological, and historical values would possibly be greater than those on the proposed route because the alternate would cross 12 more miles of areas rated as medium archaeological sensitivity.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Transmission towers and conductors would be highly visible from U.S. Highway 89 in spite of measures to mitigate visual and aesthetic impacts. Nineteen acres more would be occupied by this alternate. In addition the alternate could result in a greater impact on archaeological values than the proposed route.

Agua Fria alternate

Description of alternate action

The Agua Fria alternate (Illustrations VIII-42 and VIII-43) would follow the same alignment as the proposed route for the first 236 miles. At a point east of Dewey, Arizona, the alternate would turn south, crossing State Highway 69 northeast of Cordes Junction, and continue south just east of Cleator and west of Bumble Bee along the east foothills of the Bradshaw Mountains. The route would cross the Agua Fria River at a point 1 mile north and 3 miles east of Lake Pleasant Regional Park. The alternate would join the proposed route at this point, 18.2 miles north of the Westwing substation. Total length of the Agua Fria alternate would be 296 miles, 3 miles shorter than the proposed route.

Description of the environment

Recreational resources on the Agua Fria alternate route differ from the proposed route because the alternate would pass through the Black Canyon Trail Area designated by the Secretary of the Interior. This area is heavily used by recreationists as a scenic, backpacking, and horseback riding area.

The Bureau of Land Management, through its planning system and public meetings, has also designated a transmission system right-of-way corridor in the Black Canyon area. This corridor follows the alignment of two existing Arizona Public Service (APS) 500 kV power lines east of Interstate 17. The proposed route would follow this corridor.

The U.S. Forest Service has proposed the southeast part of the Prescott National Forest, west of Interstate 17, for inclusion in the National Wilderness Preservation System. The proposed route would pass through or near the east side of this area.

This alternate would cross a perennial section of the Agua Fria River where the endangered Gila topminnow may exist. This alternate would also pass through the habitat of an isolated antelope herd and a nesting habitat along the Agua Fria River used by the black hawk. The black hawk is classified as a "peripheral" species by the U.S. Fish and Wildlife Service.

The alternate route would bypass the sensitive Perry Mesa Archaeological District discussed in Chapter II. Also of historical significance are numerous old mining camps and diggings in the area.

Environmental impacts of alternate action

The Agua Fria alternate would degrade scenic and natural qualities in the Black Canyon Trail Area, and could reduce primitive values of the proposed wilderness area in the Prescott National Forest. The alternate would detract

from historical values of old mining camps in the area, but would avoid the Perry Mesa Archaeological District. Although the alternate could reduce or damage habitat used by antelope, black hawk, and the Gila topminnow, it would not have as great an impact on wildlife as the proposed route, because it would avoid critical antelope kidding and mule deer fawning grounds on Perry and Black mesas.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Intrusions on scenic, natural, and primitive qualities by commitment of the land to a utility corridor could not be avoided. Also, reduction of or damage to wildlife habitat could not be completely mitigated.

Pinnacle Peak alternate

Description of alternate action

The Pinnacle Peak alternate (Illustrations VIII-37 and VIII-43 through VIII-47) would follow the Kaiparowits to Westwing proposed route to the Moenkopi switchyard. It would then turn south and follow the Bureau of Reclamation 345 kV transmission line to Gray Mountain and continue south along the west side of U.S. Highway 89 to an area west of the Wupatki National Monument. From there the line would turn south-southeast across U.S. Highway 89, and pass approximately 1 mile east of Cleary Peak and Sunset Crater National Monument. It would continue to Winona and cross Interstate 40, and then head south passing east of Mormon Lake, Hutch Mountain, and Happy Jack. The route would then turn southwest passing over Buck Mountain, east of Buckhorn Mountain, past Childs power plant on the Verde River, and through Bloody Basin to near West Cedar Mountain. The alternate would continue following the Bureau of Reclamation 345 kV right-of-way west past Humbolt

Mountain Lookout. The alternate would then turn southeast past Ramm Mountain, turn southwest past Kentuck Mountain, and proceed west of Granite Mountain to Pinnacle Peak substation. From here the alternate would go due west to Westwing substation. Total length would be 301 miles, 2 miles longer than the proposal.

Description of the environment

The Pinnacle Peak alternate is similar to the proposal with the exception of 32 miles of productive ponderosa pine forest east of Mormon Lake near Flagstaff, Arizona. This area receives heavy recreation use because of the numerous small lakes and forest environment. Visual quality of this route is higher than that of the proposed. The alternate would pass through habitat of the endangered peregrine falcon and critical winter habitat for waterfowl, golden eagle, and the endangered bald eagle.

Environmental impacts of alternate action

Major differences in impacts would be to vegetation, wildlife and recreation resources. Critical wildlife habitat used by two endangered species (peregrine falcon and bald eagle), waterfowl, and the golden eagle would be reduced. The alternate would reduce the annual allowable cut in the Coconino National Forest by 140,000 board feet and 130 cords of pulpwood. Over the life of the project (50 years), 7 million board feet and 6,500 cords of pulpwood would be lost. There would be a lesser impact to soils and ground cover along this alternate, but ground disturbance through the forest would create another major visual intrusion and reduce the quality of outdoor recreation.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The commitment of the land, loss of scenic quality, loss of timber production, and potential loss of raptor habitat are impacts that cannot be mitigated during the life of the project.

Antelope-Hualapai alternate

Description of alternate action

The Antelope-Hualapai alternate (Illustrations VIII-34, VIII-40, and VIII-48 through VIII-53) would follow the proposed Kaiparowits-Eldorado route for 70 miles to a point about 10 miles southwest of Fredonia, Arizona. The alternate would turn southwest for 26 miles, cross Antelope Valley (elevation 5,000 feet), and then turn more to the south through Toroweap Valley. The route would cross this valley for about 10 miles, skirt the east slopes of Mount Trumbull, and continue past the mountain for 3 miles. The route would then angle southwest for about 8 miles through rough terrain to a point about 3 miles north of the Grand Canyon National Park boundary in Whitmore Canyon. At this point the route would turn south, enter the park, and pass through Whitmore Canyon and then Grand Canyon, crossing the park area for 3 miles. The river crossing (elevation 4,500 feet) would be about 2 miles upstream from Whitmore Rapids, a pick-up point for rafting parties.

After crossing the Grand Canyon and entering the Hualapai Indian Reservation, the alternate would turn southeast for 2 miles to a plateau, cross it for about 4 miles, and descend into Prospect Valley (elevation 5,700 feet). The alternate would follow the valley for 2 miles, and turn southeast to ascend the Aubrey Cliffs to a plateau at 6,000-foot elevation. The alternate would then continue across the Hualapai Indian Reservation for about 20 miles, pass east of Rose Well and Round Mountain, and rejoin the proposed Kaiparowits to Phoenix route 6 miles east of Ash Fork and 1 mile north of I-40. Total length of the

Antelope-Hualapai alternate would be 335 miles, or 36 miles longer than the proposed route.

Description of the environment

Air quality is higher along the Antelope-Hualapai alternate, since the route avoids the Navajo generating plant at Page. Another difference between the existing environment along this alternate route and the proposed route is the proposed crossing of the Grand Canyon 2 miles up river from Whitmore Rapids. Crossing of the Colorado River by the proposed route would be within Glen Canyon National Recreation Area, while the Hualapai-Antelope crossing would fall within the Grand Canyon National Park. The alternate would pass through important elk habitat and golden eagle nesting areas. The alternate would bypass the Navajo Indian Reservation.

Environmental impacts of alternate action

Since the Antelope-Hualapai alternate would cross 145 miles of undisturbed land and would be 36 miles longer than the proposed route, it would result in the disturbance of 338 more acres. In addition the alternate would reduce natural values in inaccessible areas north and south of the Grand Canyon.

Aesthetic impacts would be greater because the alternate would cross the Grand Canyon. Although this part of the canyon is not easily accessible, transmission lines would be visible to recreational users, such as raft parties on the river. The alternate would also conflict with the legislation that extended the boundary of Grand Canyon National Park. There would be a reduction in wildlife habitat, an increase in human disturbance, and potential for archaeological and historical losses along the alternate.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Antelope-Hualapai alternate would result in disturbance of 338 acres more than the proposed route. It would also create greater aesthetic impacts because the line would cross the Grand Canyon, 3 miles of Grand Canyon National Park, and 145 miles of virtually undisturbed lands. In addition, the alternate would conflict with the legislation that extended the park boundary. Potential for loss of undiscovered archaeological and historical values is also greater along the alternate.

Antelope-Wickenburg alternate

Description of alternate action

The Antelope-Wickenburg alternate (Illustrations VIII-43 and VIII-52 through VIII-56) would follow the same route as the Antelope-Hualapai alternate to the Aubrey Cliffs on the Hualapai Indian Reservation. At this point the Antelope-Wickenburg alternate would turn south and follow the cliffs through Aubrey Valley and cross Highway 66 about 8 miles northwest of Seligman. The alternate would continue south through the northwest corner of the Prescott National Forest, cross the Juniper Mountains, and begin a slight curve to the south-southeast. It would then descend the south face of Behm Mesa, turn south-southwest, and pass east of Bismark Mountain. The route would again turn south-southeast between the Weaver and Date Creek mountains, cross U.S. Highway 89 and Arizona Highway 71 about 4 miles southwest of Yarnell, and continue southeast for about 17 miles to a point 5 miles northeast of Wickenburg. From here the alternate would turn farther southeast and follow the south edges of the Wickenburg and Hieroglyphic mountains to Westwing substation. This alternate would be 335 miles long, about 36 miles longer than the proposed route.

Description of the environment

The Antelope-Wickenburg alternate would create 264 more miles of new transmission line corridor than the proposed route, crosses 5 additional miles of

fragile Sonoran desert scrub, and cross 16 more miles of ponderosa pine forest. Soils in the Sonoran desert scrub community have low soil moisture which results in low vegetative productivity and rehabilitation potential once the soils are disturbed.

The Antelope-Wickenburg alternate has not been surveyed for archaeological, cultural, or historical resources to the same degree as the general area of the proposed route.

Environmental impacts of alternate action

The major differences between the Antelope-Wickenburg alternate and the proposed route would be the impacts resulting from construction of 264 miles of new corridor over undisturbed lands. This would result in proportionately more disturbance of soils, vegetation, wildlife habitat, and archaeological and historical values.

Impacts on archaeological and historical resources along the alternate route could be greater than along the proposed route since new roads would be opened into previously inaccessible country. However, since little archaeological data are available for this alternate, potential impacts cannot be compared.

Based on an average of 9.4 disturbed acres per mile of transmission line, construction activities would cause surface disturbance to an estimated 338 acres more than the proposed route. This would include 35 additional acres of Sonoran desert scrub and 112 additional acres of ponderosa pine-Douglas fir forest. The proposed route would have no effect on the forest area. The alternate would result in greater impacts on soils since it would be greater in length, create many more miles of new corridor, and cross more miles of soils with low rehabilitation potential.

Finally, this alternate would also create the same impacts as the Antelope-Hualapai alternate where both follow the same route.

Mitigating measures

Same as the proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Alternate route construction activities would generally result in the same types of unavoidable impacts as would occur on the proposed route, although more acres of vegetation, soils, and wildlife habitat would be disturbed along the alternate. In addition the alternate would disturb 112 acres of ponderosa pine-Douglas fir forest in the Prescott National Forest while the proposed route would have no impact on the forest. Impacts on archaeological and historical values cannot be compared because little is known of such values along the alternate.

There would also be unavoidable disturbance of about 259 acres (35 more than the proposal) of soils in the Sonoran desert scrub community which have low rehabilitation potential.

Impact evaluation

An impact evaluation of all alternate transmission system routes for the Kaiparowits to Phoenix segment is contained in Figure VIII-11.

Kaiparowits to Moenkopi to Mohave

The proposed Kaiparowits to Moenkopi to Mohave alternate routes are shown in Illustrations VIII-57 through VIII-82.

John Henry and Cedar Ridge alternates

The John Henry alternate (Illustration VIII-58) and the Cedar Ridge alternate (Illustrations VIII-60 and VIII-61), both of which are discussed as alternates to the proposed Kaiparowits to Eldorado route, are also alternates to the Kaiparowits to Moenkopi to Mohave alternate.

FIGURE VIII-11

Impact Evaluation of Alternate Routes for Proposed Kaiparowits to Phoenix Route[a]

		Importance to decision making[b]	John Henry	Cedar Ridge	Agua Fria	Pinnacie Peak	Antelope-Hualapai	Antelope-Wickenburg
Mileage (more or less than proposed route)		5	+3	+2	-3	+2	+36	+36
Climate		0		NN	NN	NN	NN	NN
Air Quality		1		SS	SS	SS	SS	SS
Geology and Topography	General	1		SS	SS	SS	SS	SS
	Seismology	1		NN	NN	NN	NN	NN
	Economic geology	2		NN	NN	NN	NN	NN
Soils	Erosion hazard	5		MM	MM	MM	MM	MM
	Rehabilitation potential[c]	5		MM	MM	MH	MM	MS
Water Resources	Quality	1		SS	SS	SS	SS	SS
	Demand	1		SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	4		SM	MM	MM	MM	MM
	Acres disturbed (permanent)	5		SS	SS	SH	SM	SS
	Acres disturbed (temporary)	6		SM	SS	SH	SM	SM
Wildlife	Terrestrial	8	Same As Proposed Route	SS	HM	MH	MH	MH
	Aquatic	4		SS	HM	SM	SS	SS
Ecological Interrelationships	Terrestrial	8		SS	HM	MH	MH	MH
	Aquatic	4		NN	HM	SM	SS	SS
Paleontology		3		SS	SS	SS	SS	SS
Archaeology		8		SM	MM	MM	SM	SM
History		5		SS	SM	SM	SM	SM
Recreation	General	8		MM	MH	MH	MH	MM
	Scenic values	10		MH	MH	MH	MH	MM
	Natural values	8		MH	MH	MH	MH	MH
Land Uses	Miles of new corridor (more or less than prop.)	10		+56	+45	+24	+145	+264
	Wood Products	3		SS	SS	MH	SS	SS
	Agriculture	1		NN	NN	NN	NN	NN
Socio-Economic	Housing and services	1		MM	MM	MM	MM	MM
	Culture and attitudes	5		MH	MH	MH	MH	MH

[a]Impacts rated as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

[c]This rating is not a comparison of impacts, but instead is a comparison of rehabilitation potentials.

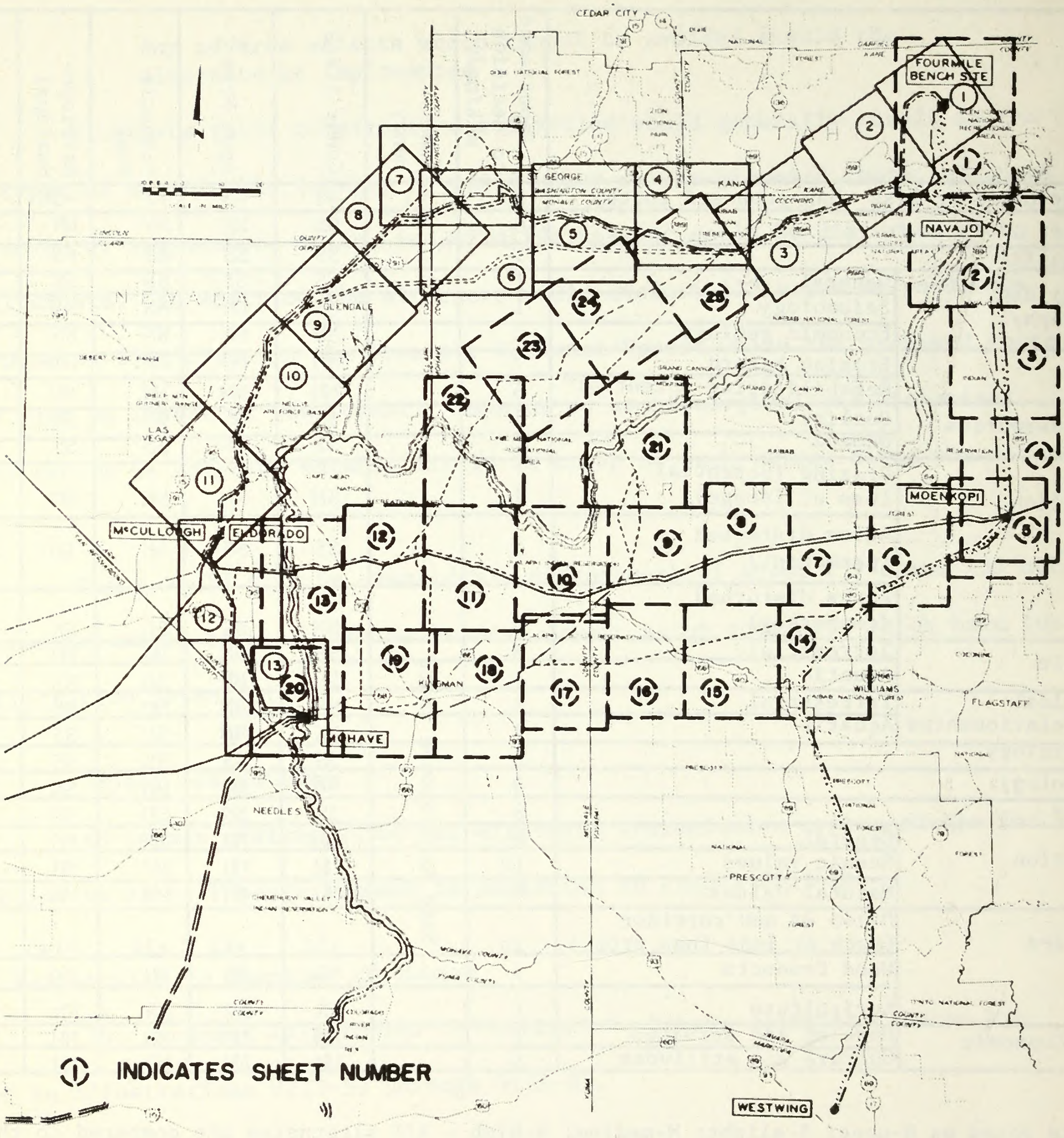

ILLUSTRATION VIII-57

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Index Sheet)

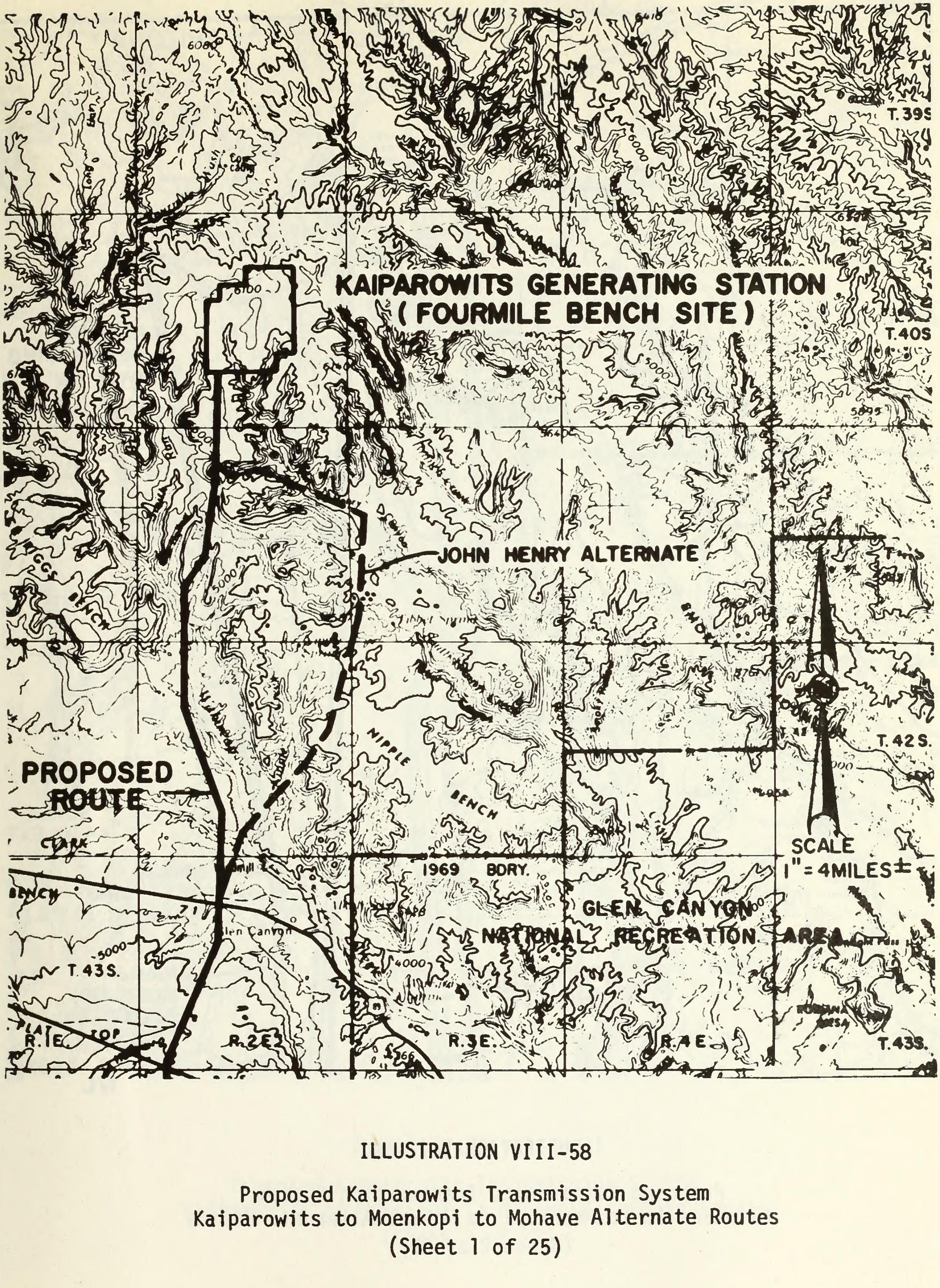

ILLUSTRATION VIII-58

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 1 of 25)

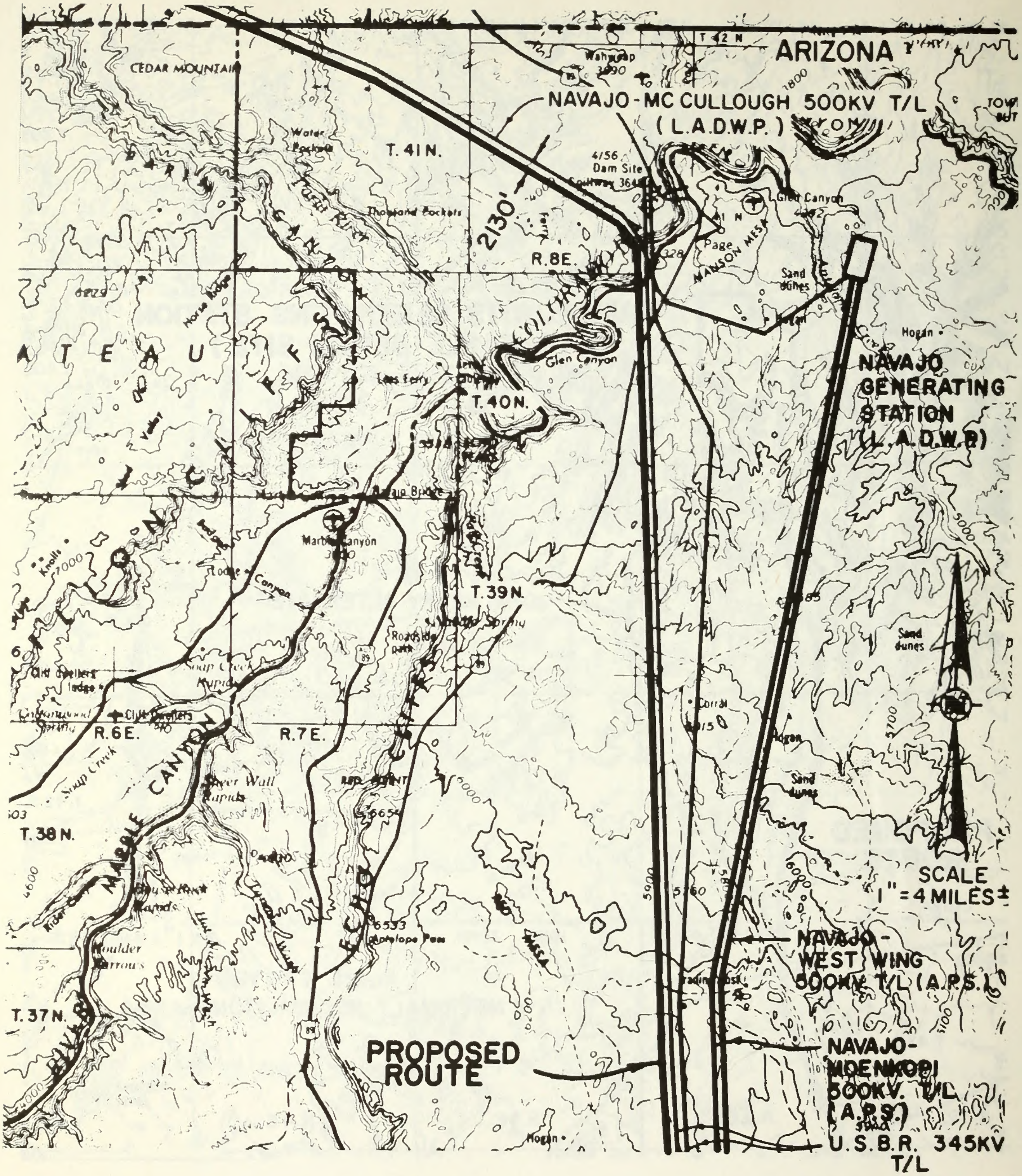

ILLUSTRATION VIII-59

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 2 of 25)

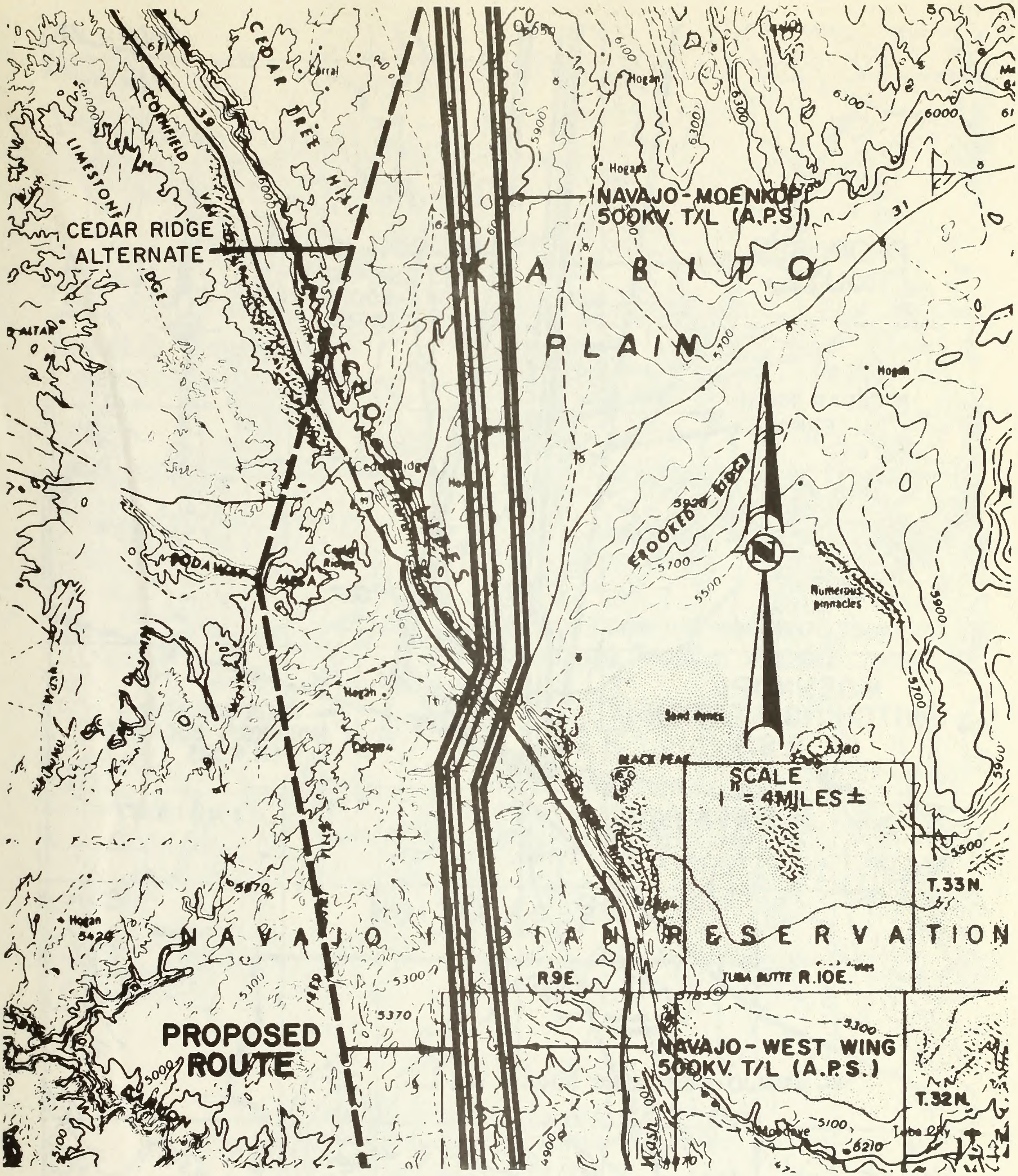

ILLUSTRATION VIII-60

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 3 of 25)

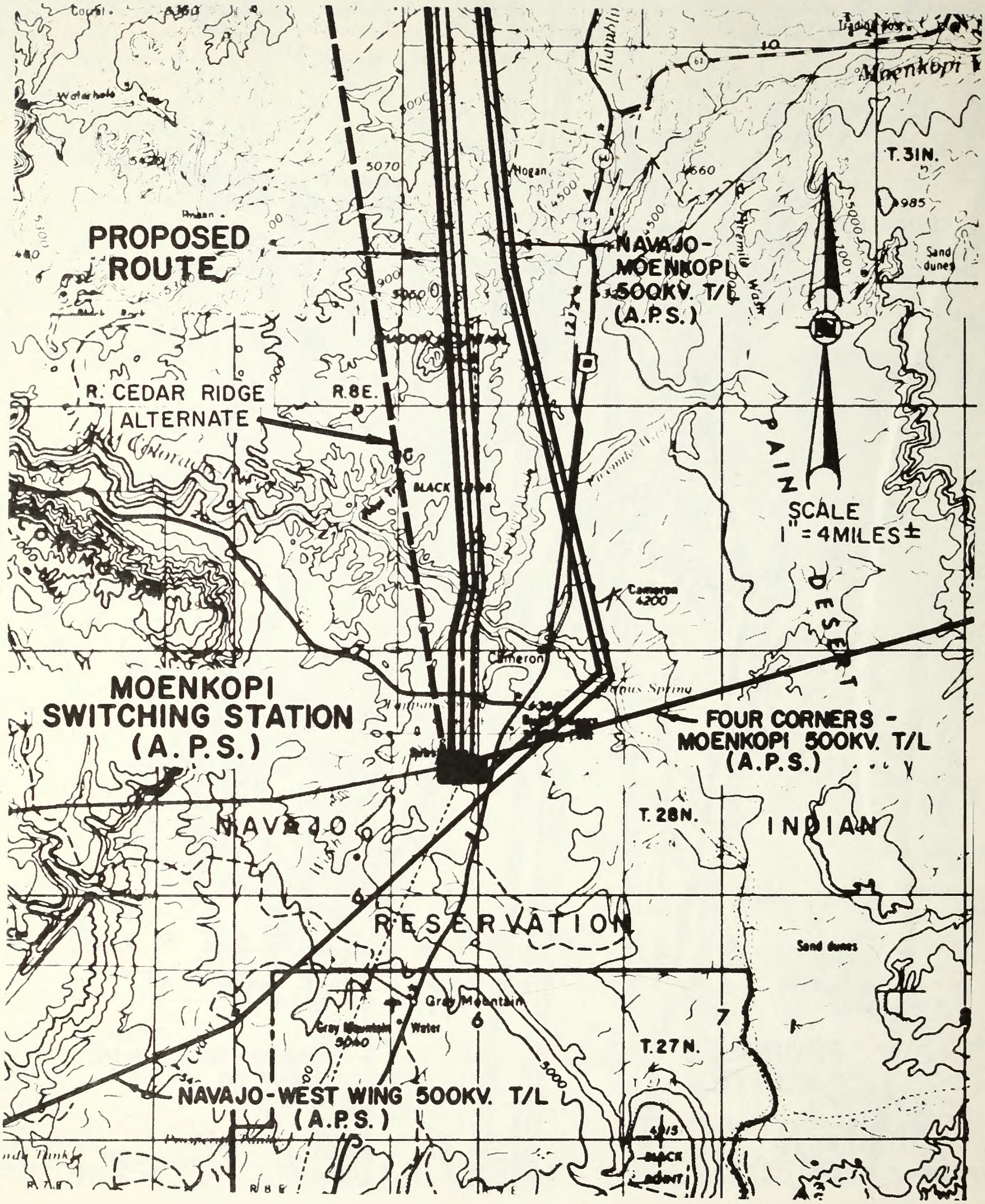

ILLUSTRATION VIII-61

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 4 of 25)

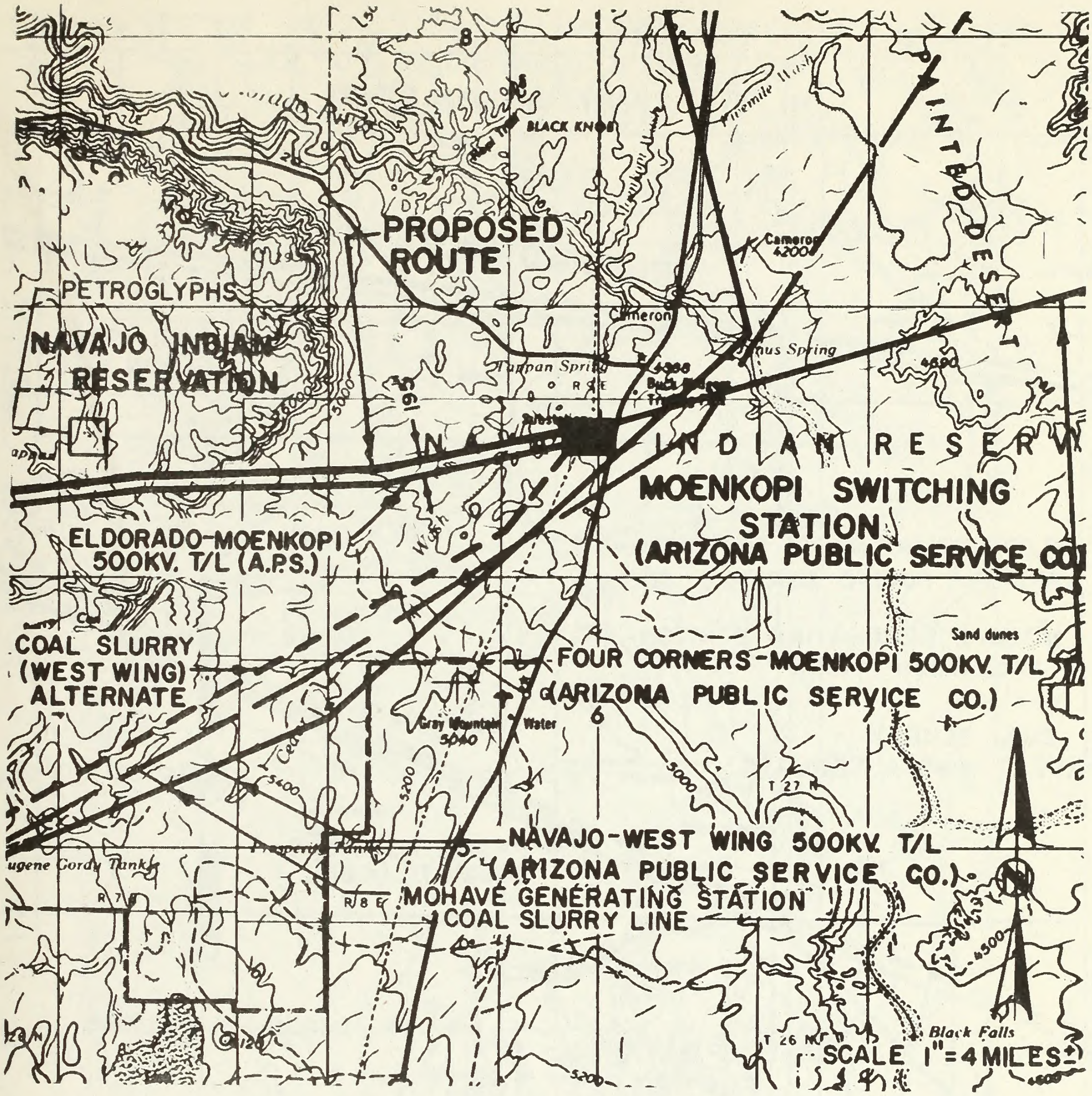

ILLUSTRATION VIII-62

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 5 of 25)

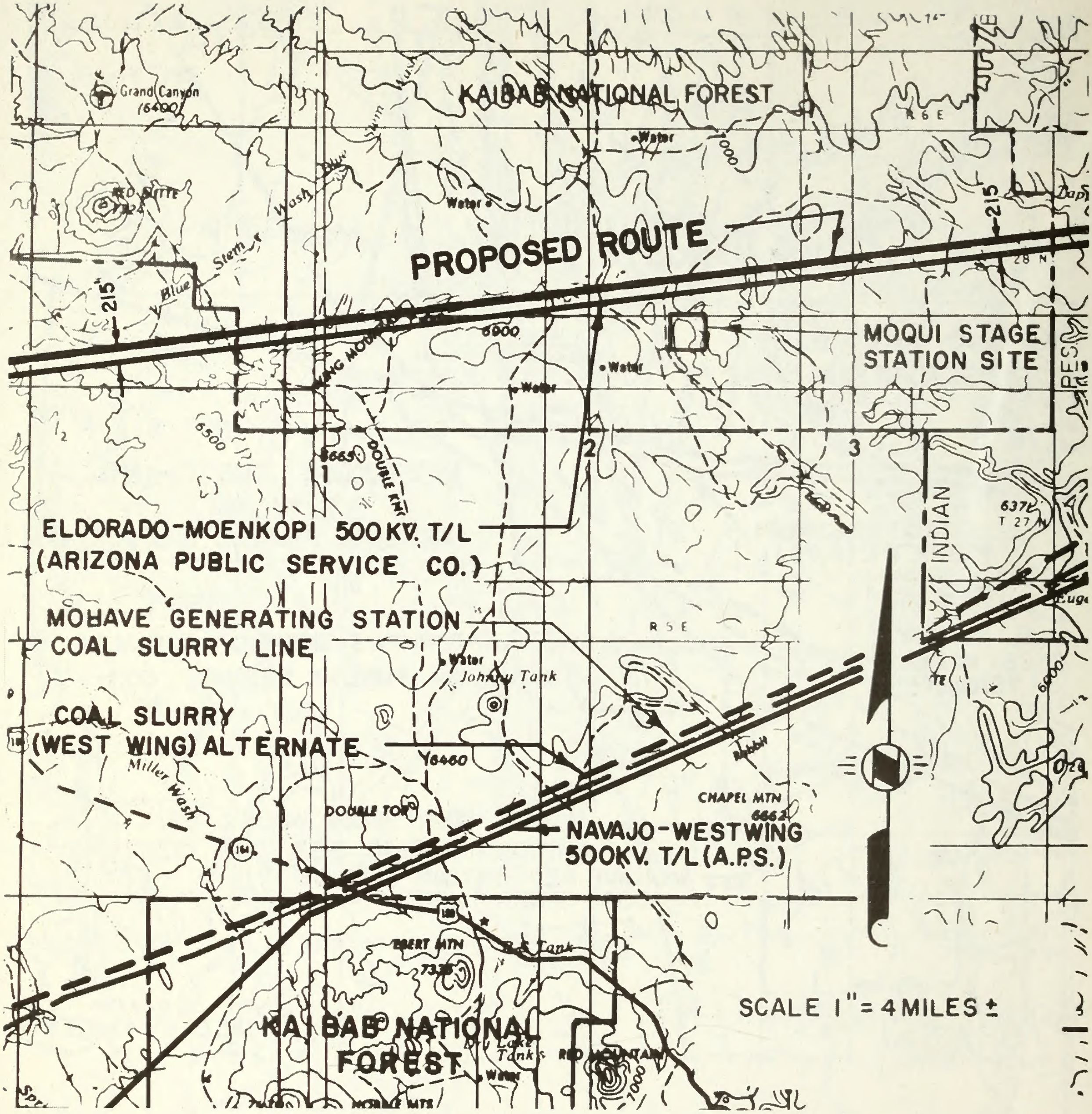

ILLUSTRATION VIII-63

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 6 of 25)

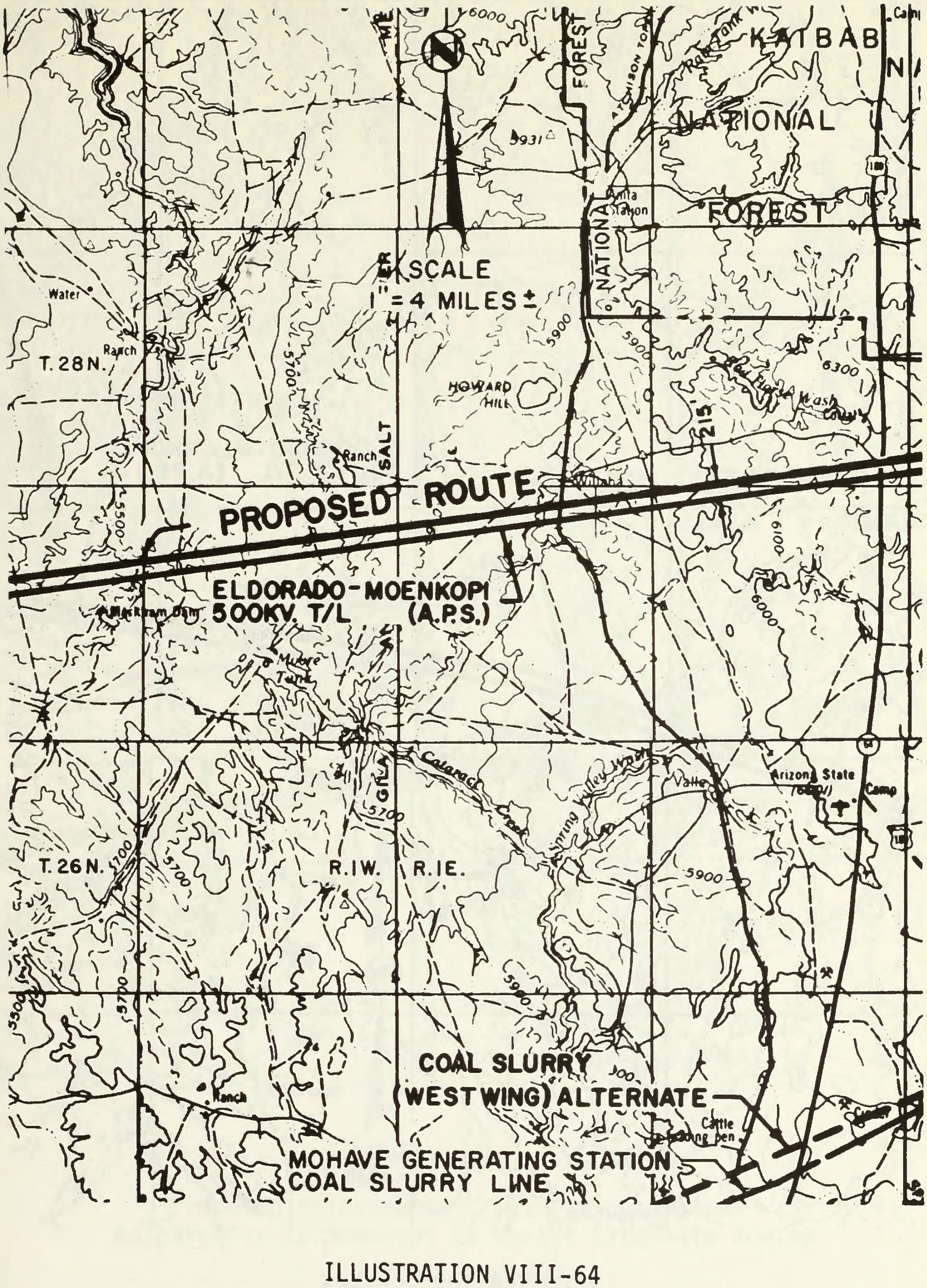

ILLUSTRATION VIII-64

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 7 of 25)

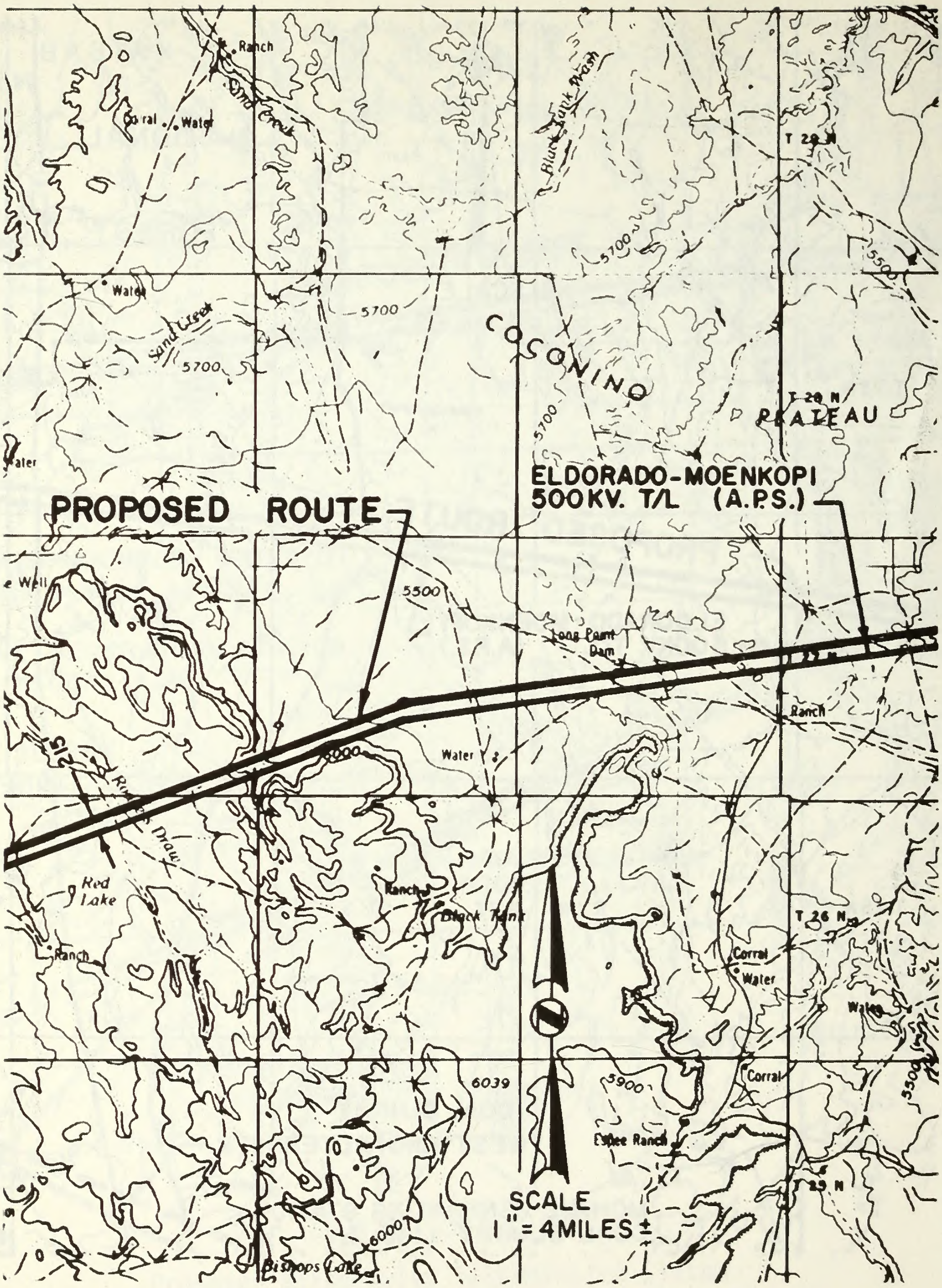

ILLUSTRATION VIII-65

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 8 of 25)

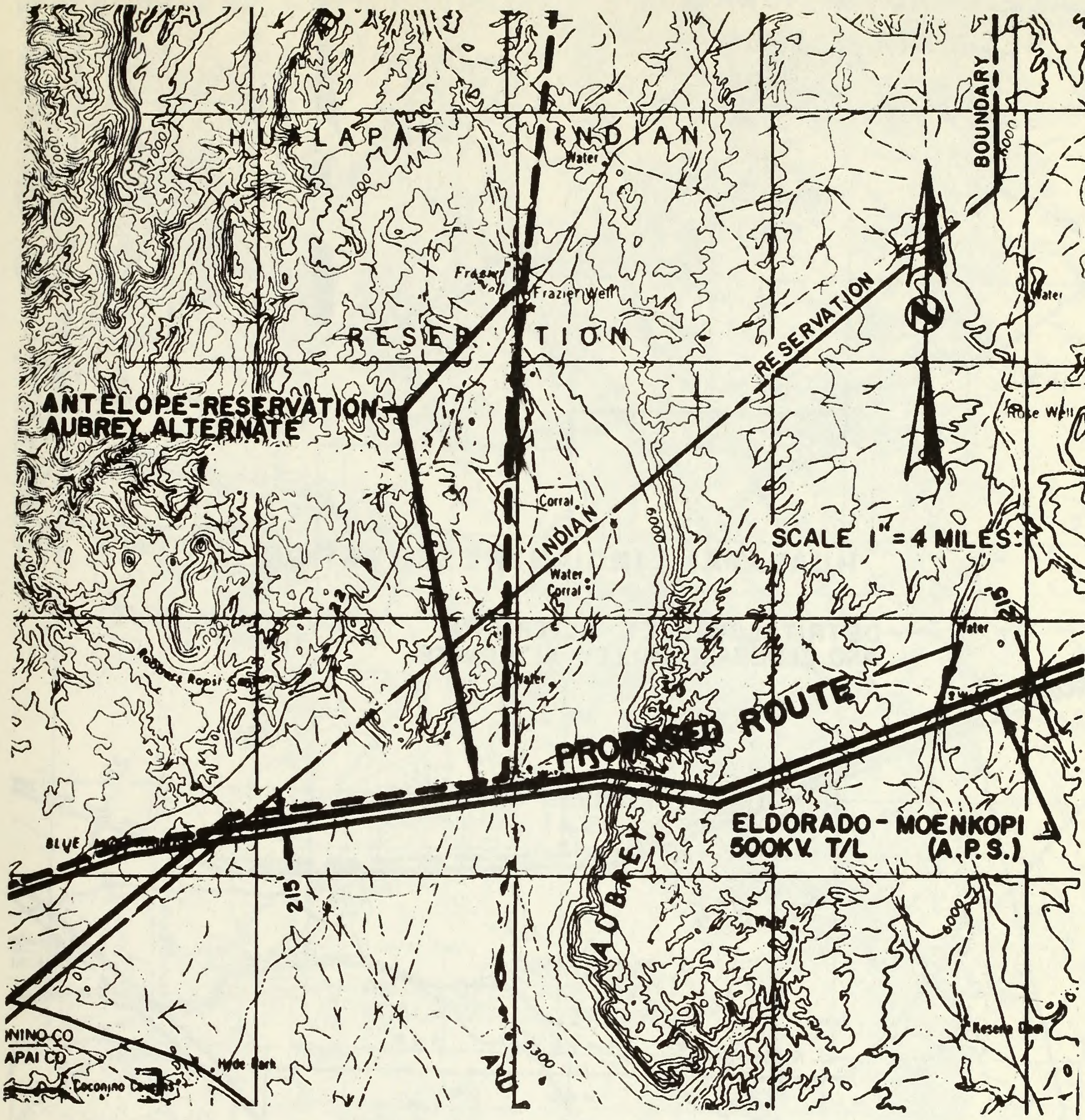

ILLUSTRATION VIII-66

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 9 of 25)

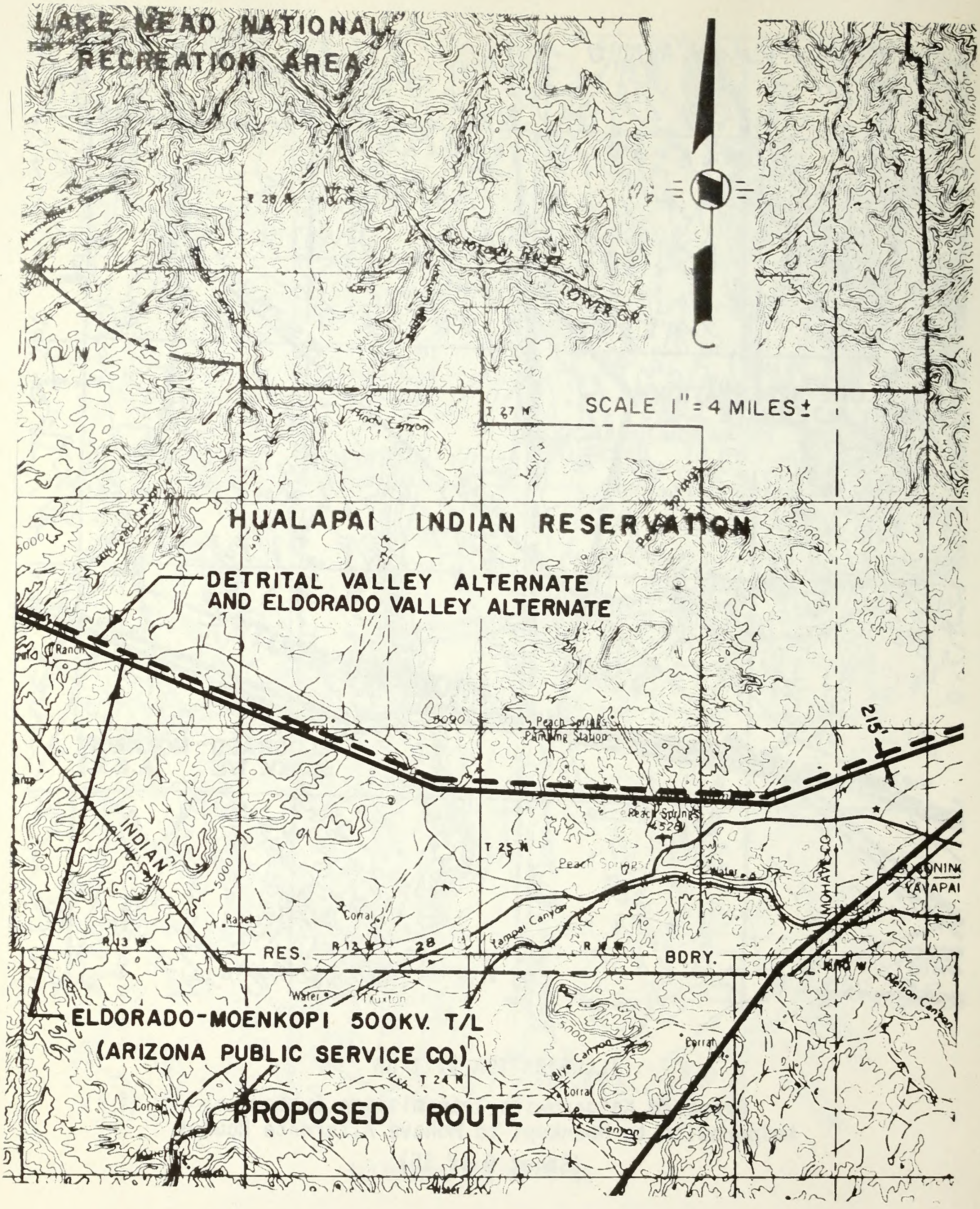

ILLUSTRATION VIII-67

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 10 of 25)

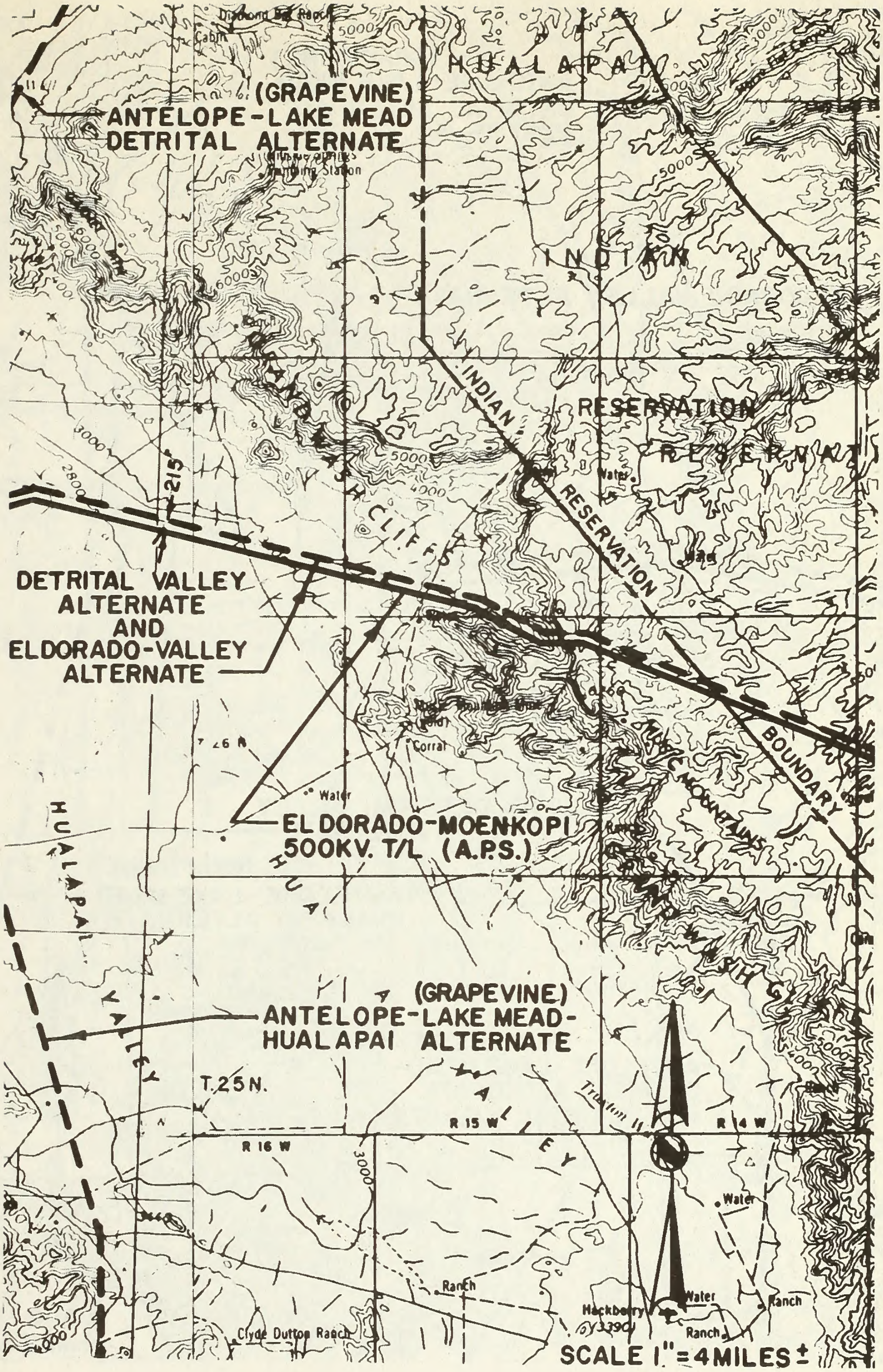

ILLUSTRATION VIII-68

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 11 of 25)

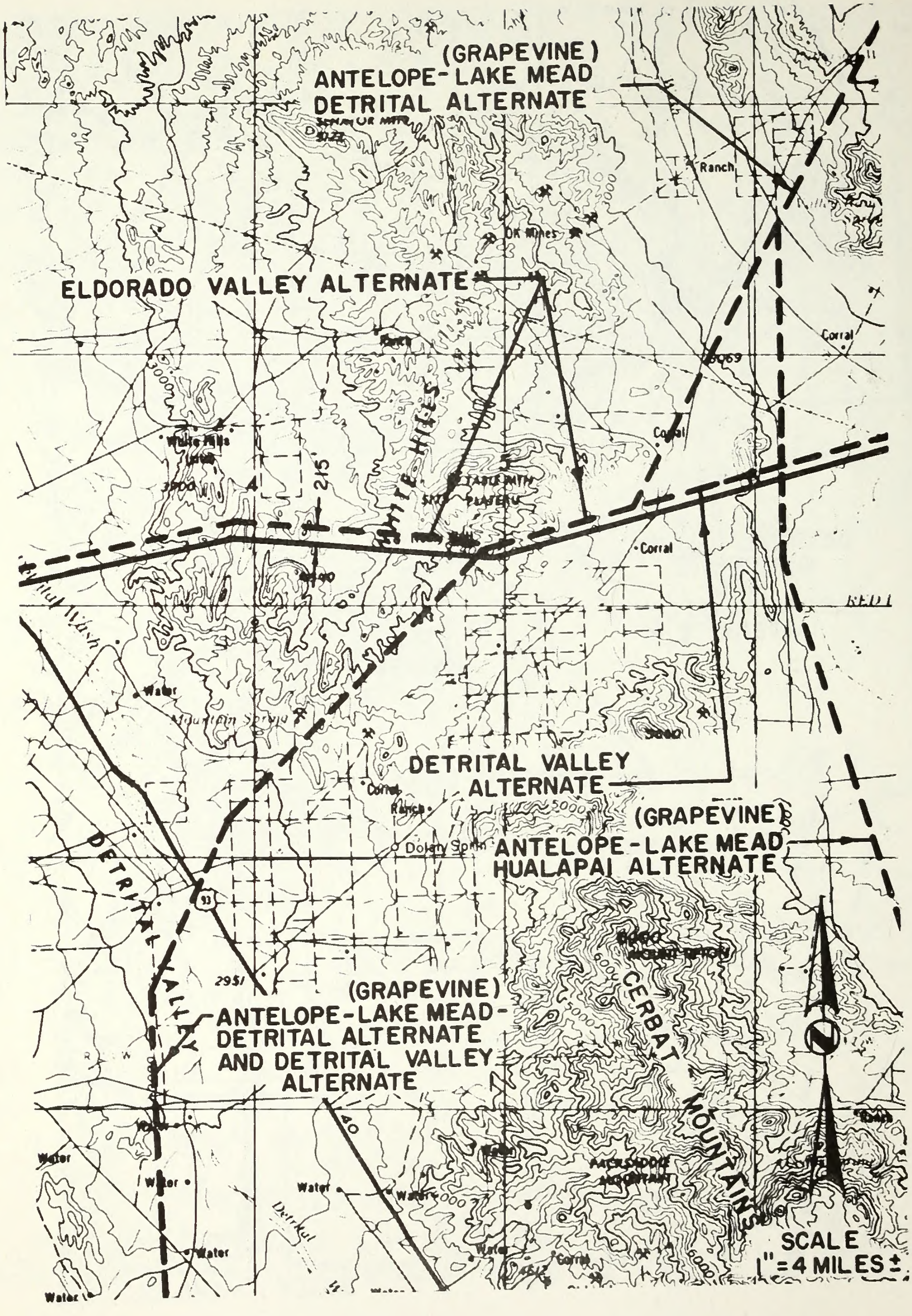

ILLUSTRATION VIII-69

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 12 of 25)

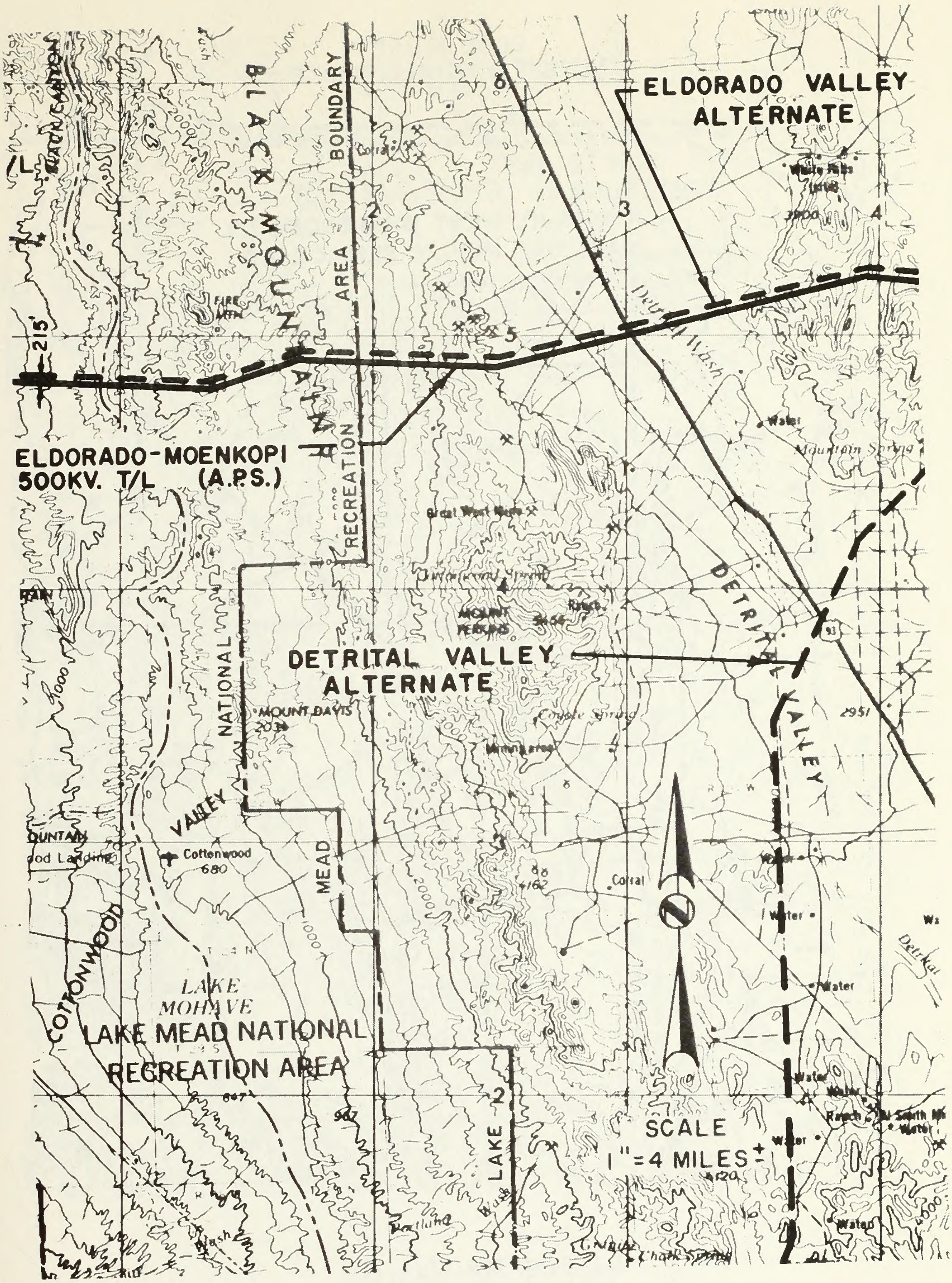

ILLUSTRATION VIII-70

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
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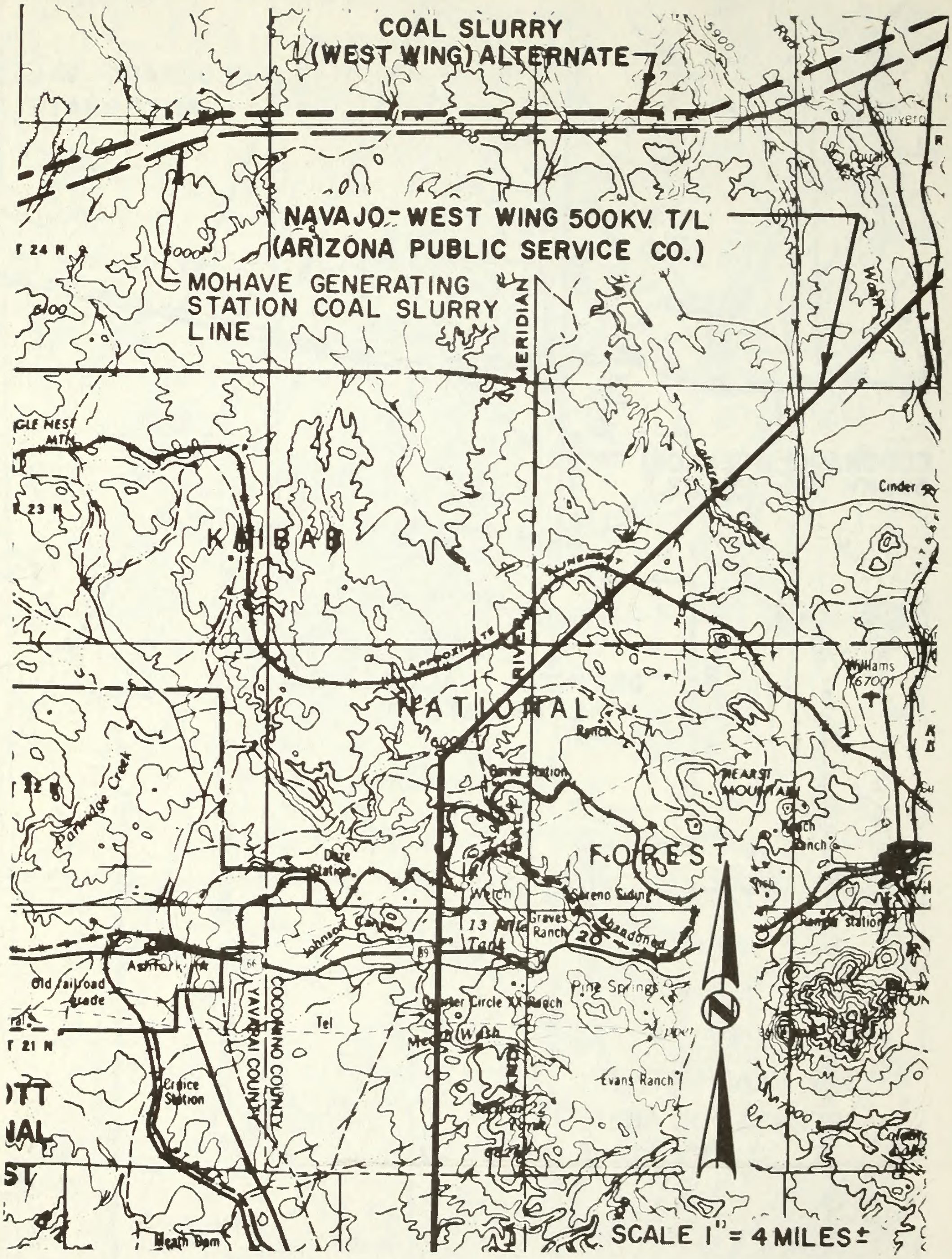

ILLUSTRATION VIII-71

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
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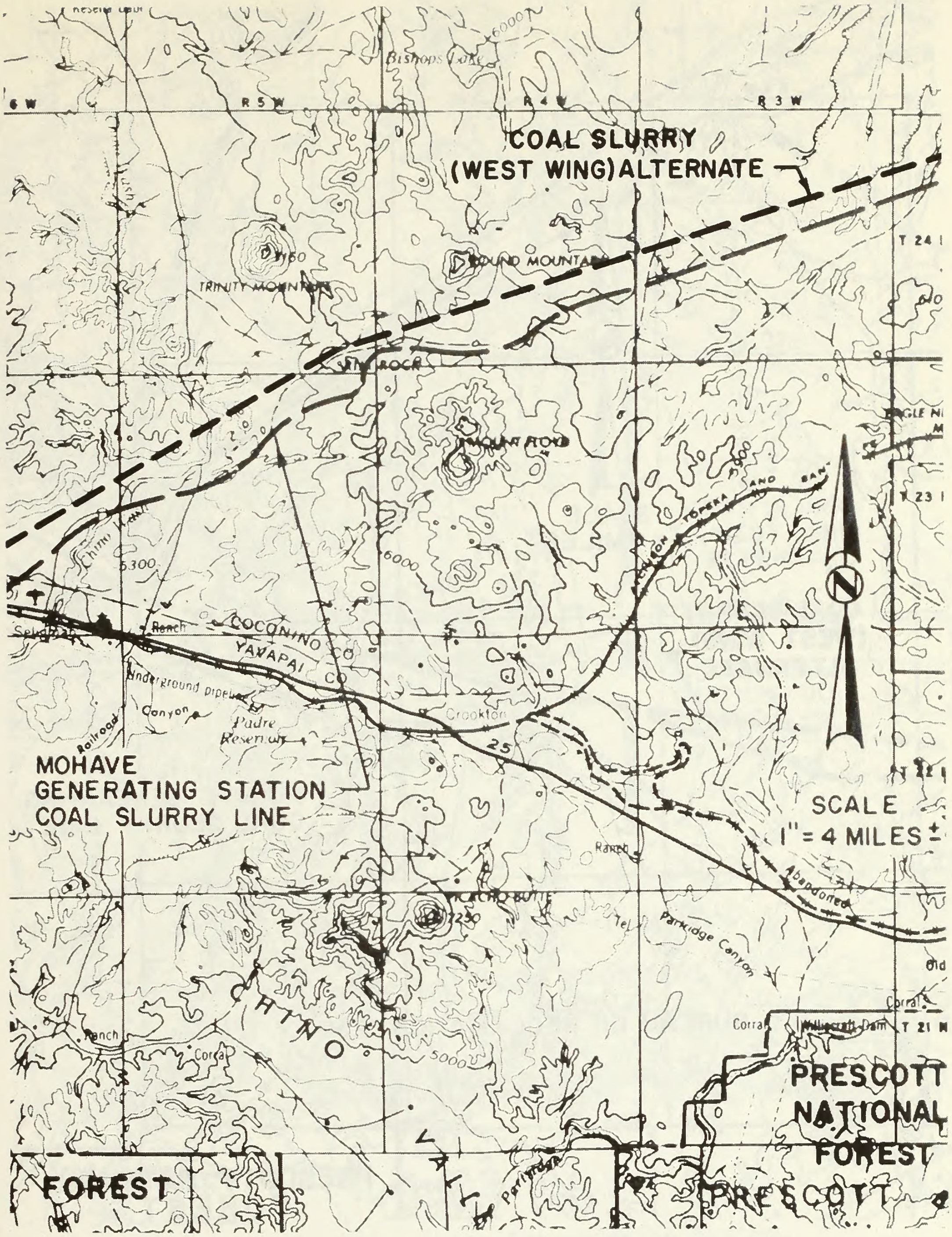

ILLUSTRATION VIII-72

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 15 of 25)

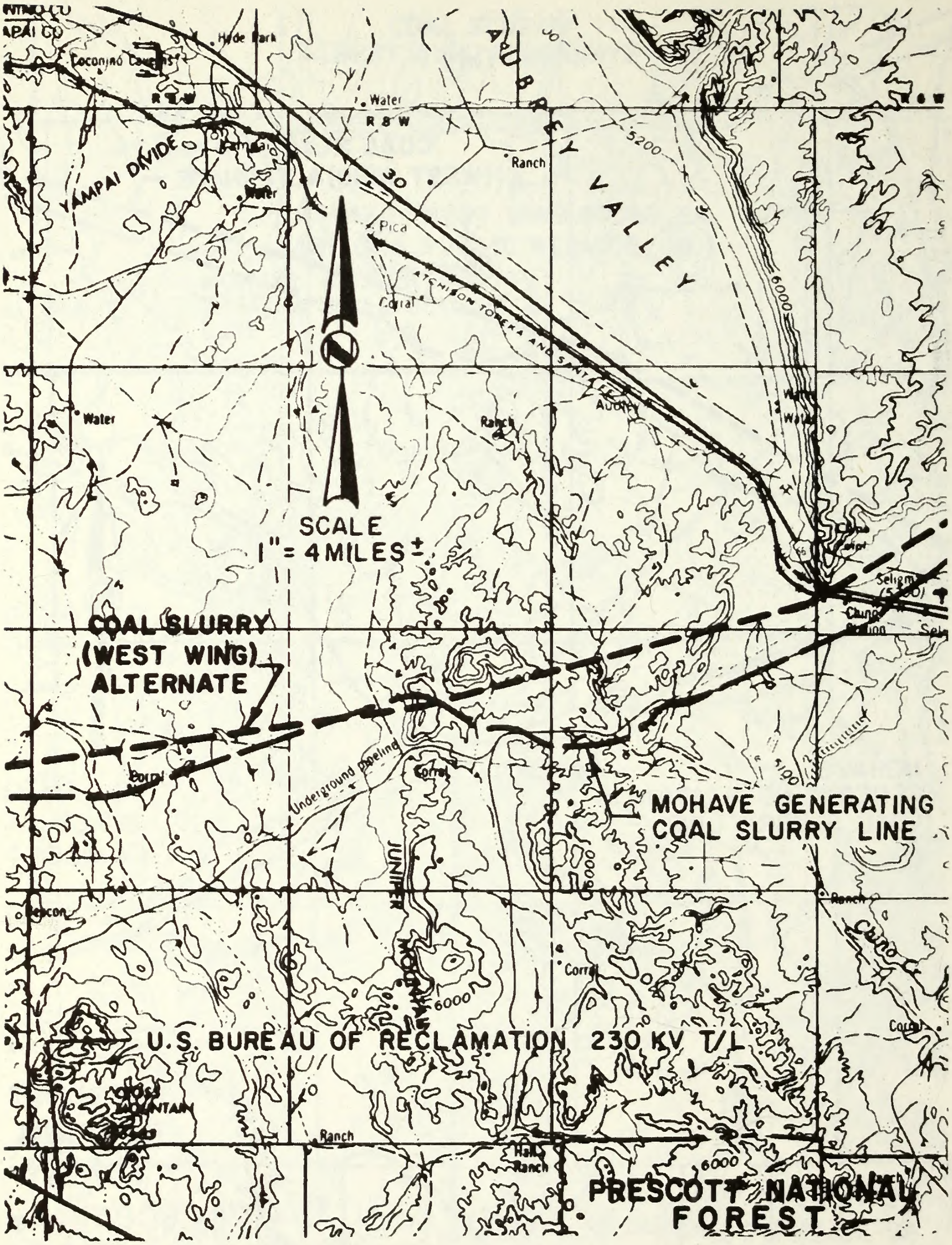

ILLUSTRATION VIII-73

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
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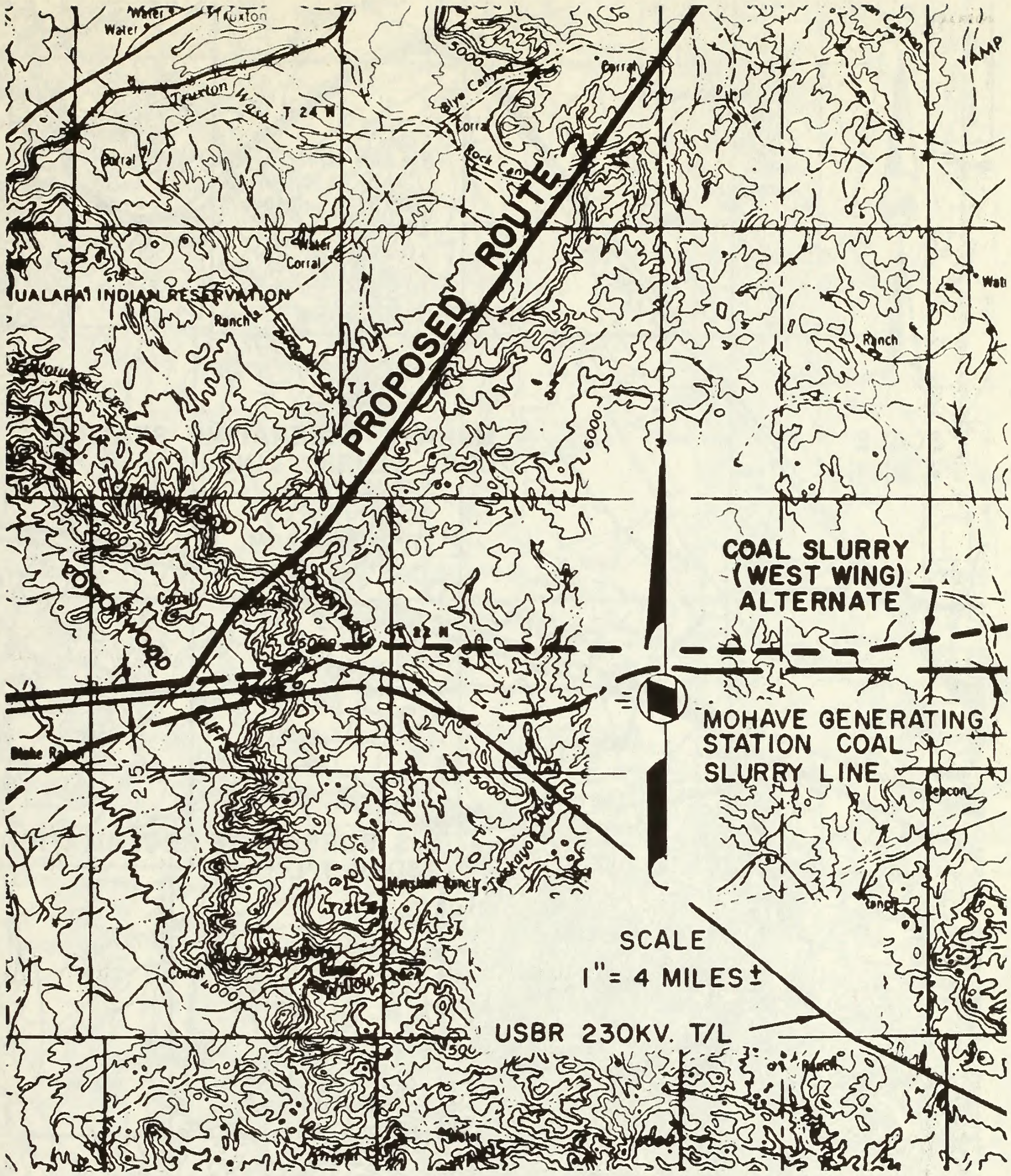

ILLUSTRATION VIII-74

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 17 of 25)

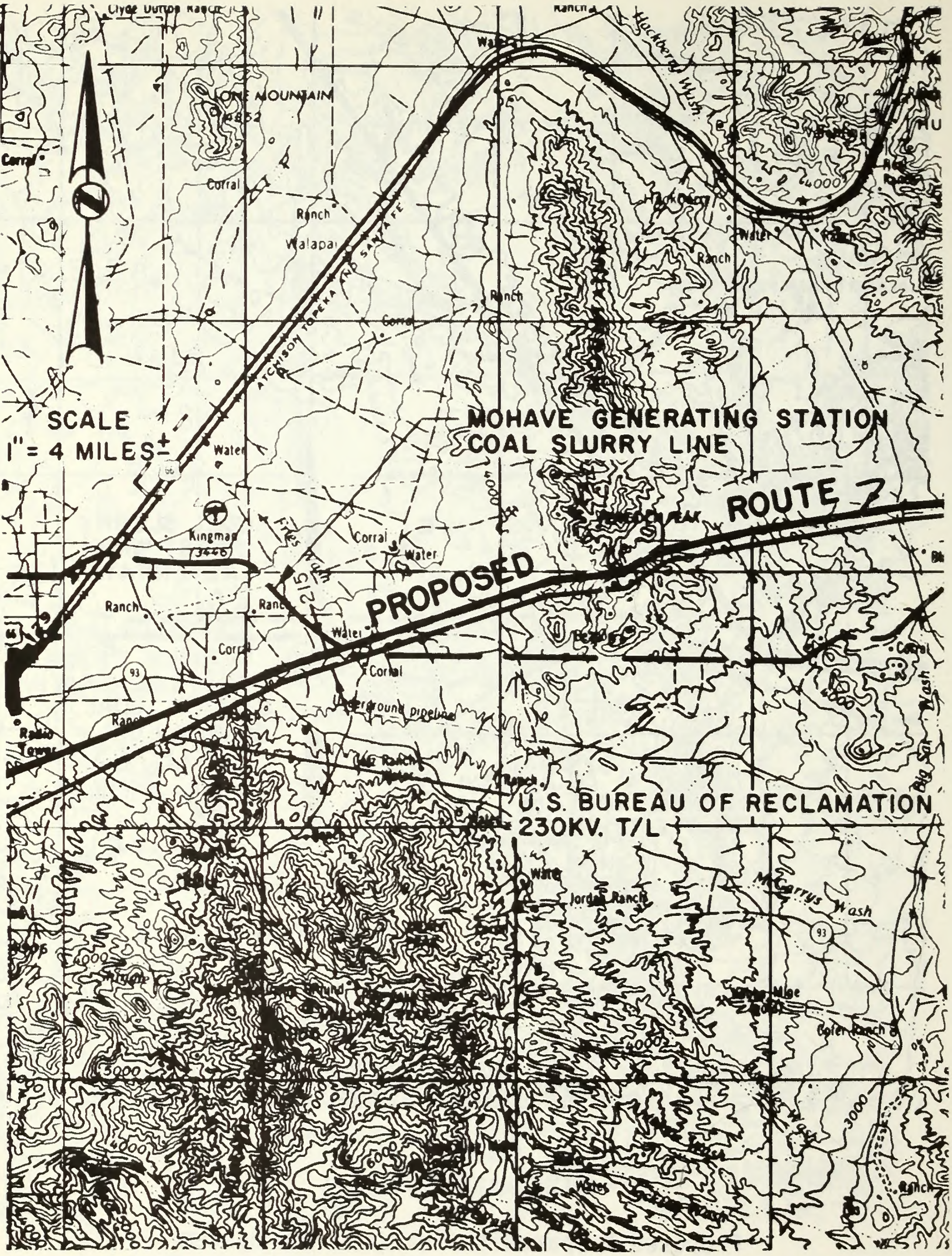

ILLUSTRATION VIII-75

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 18 of 25)

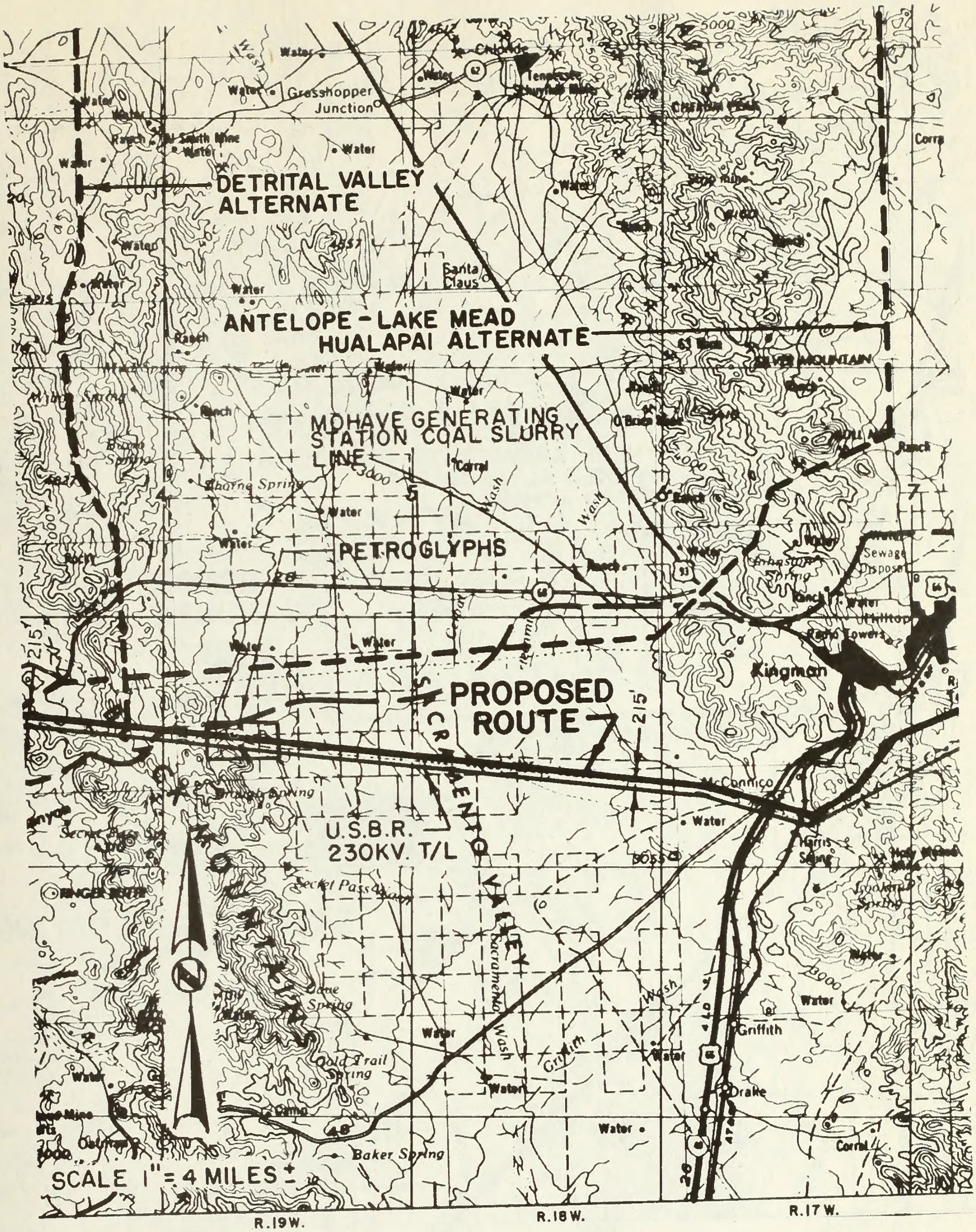

ILLUSTRATION VIII-76

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
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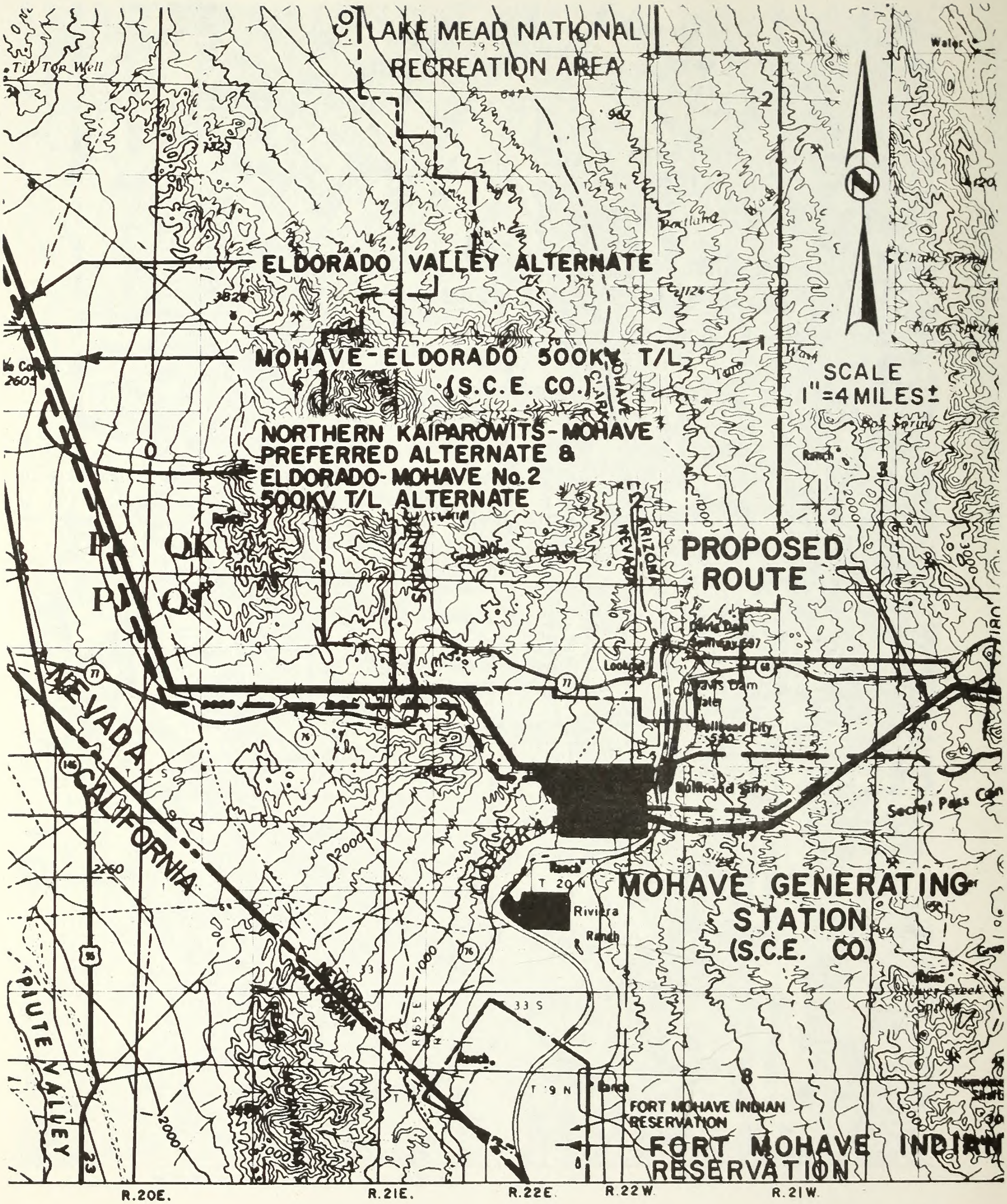


ILLUSTRATION VIII-77

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 20 of 25)

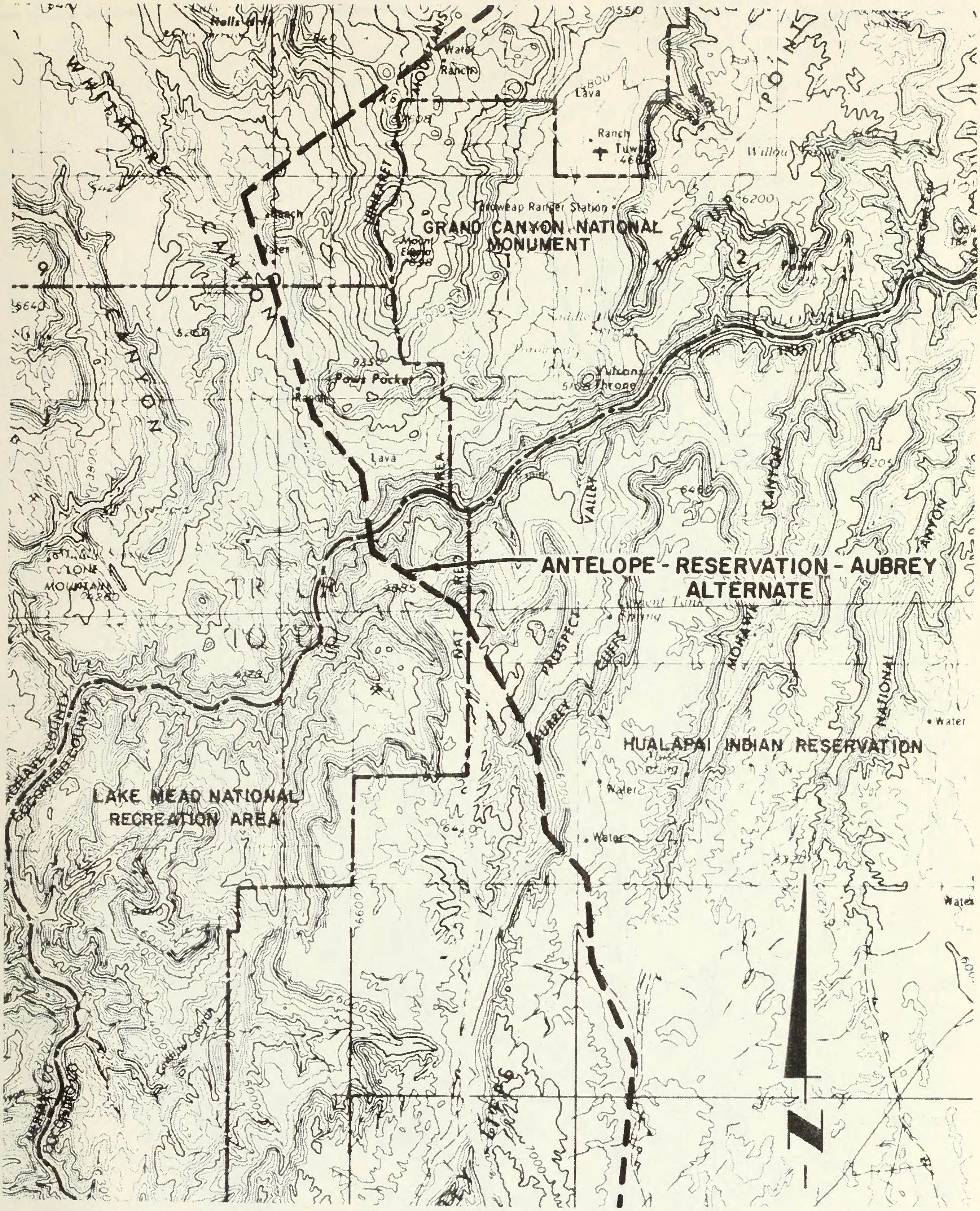


ILLUSTRATION VIII-78

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 21 of 25)

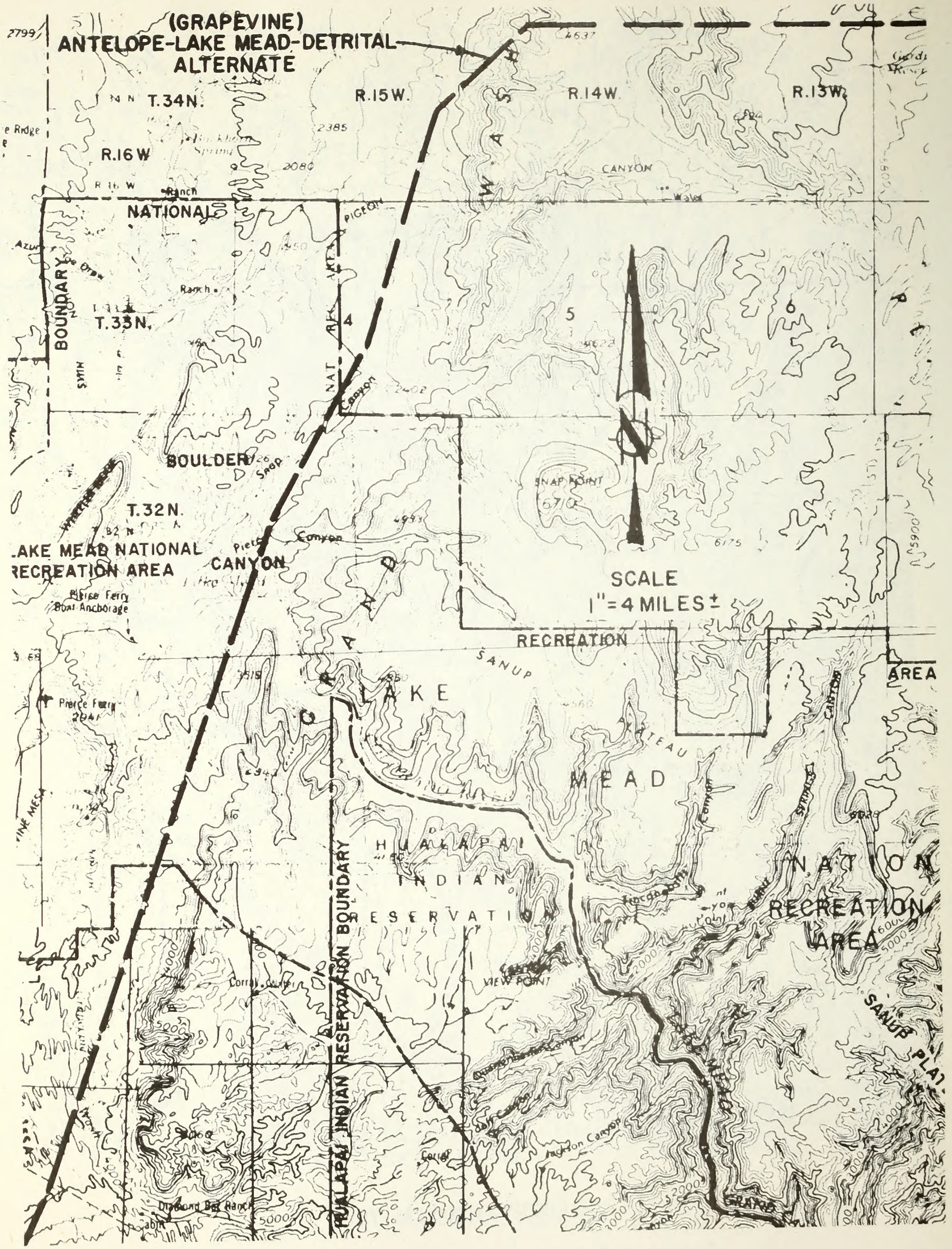


ILLUSTRATION VIII-79

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 22 of 25)

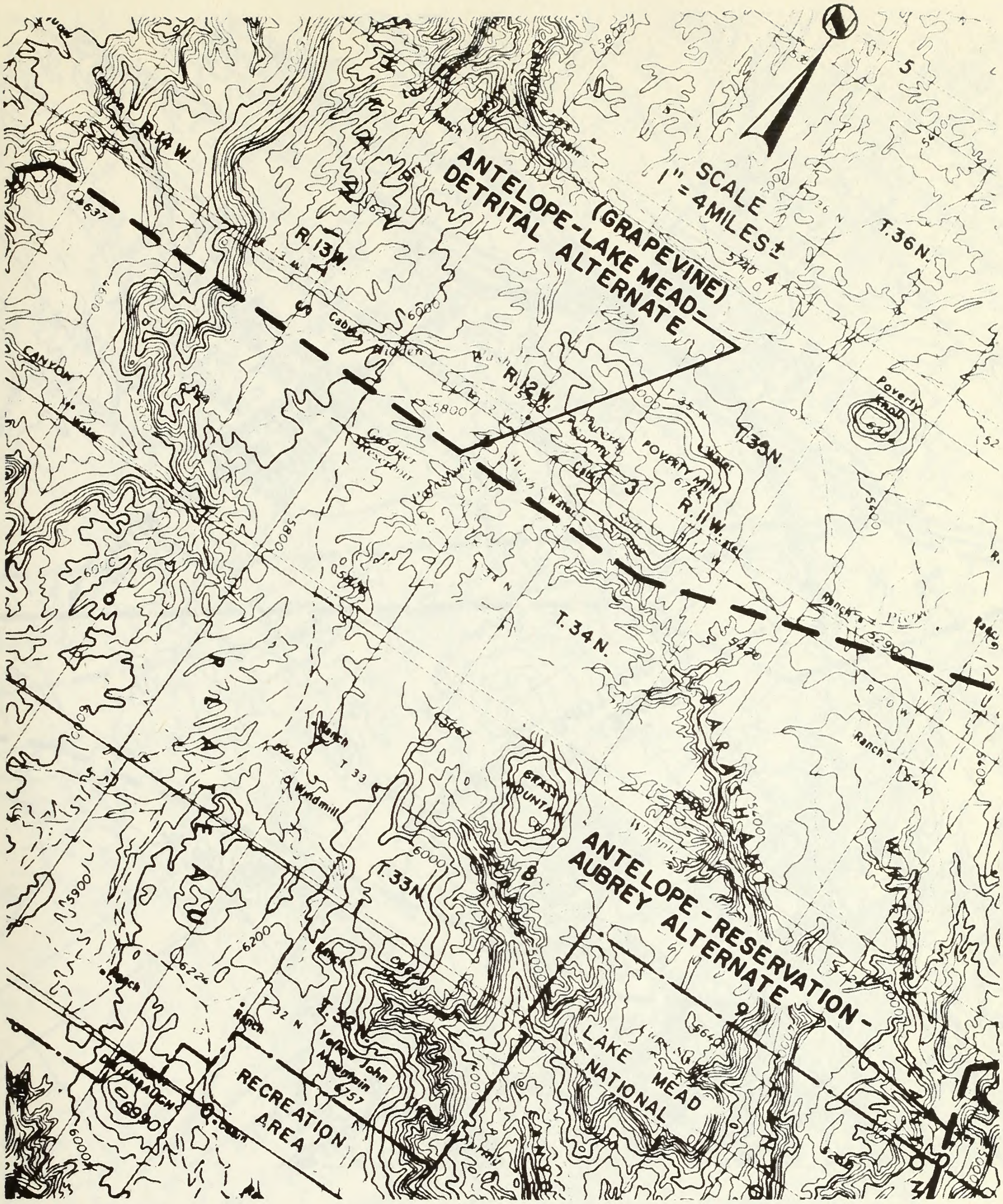


ILLUSTRATION VIII-80

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 23 of 25)

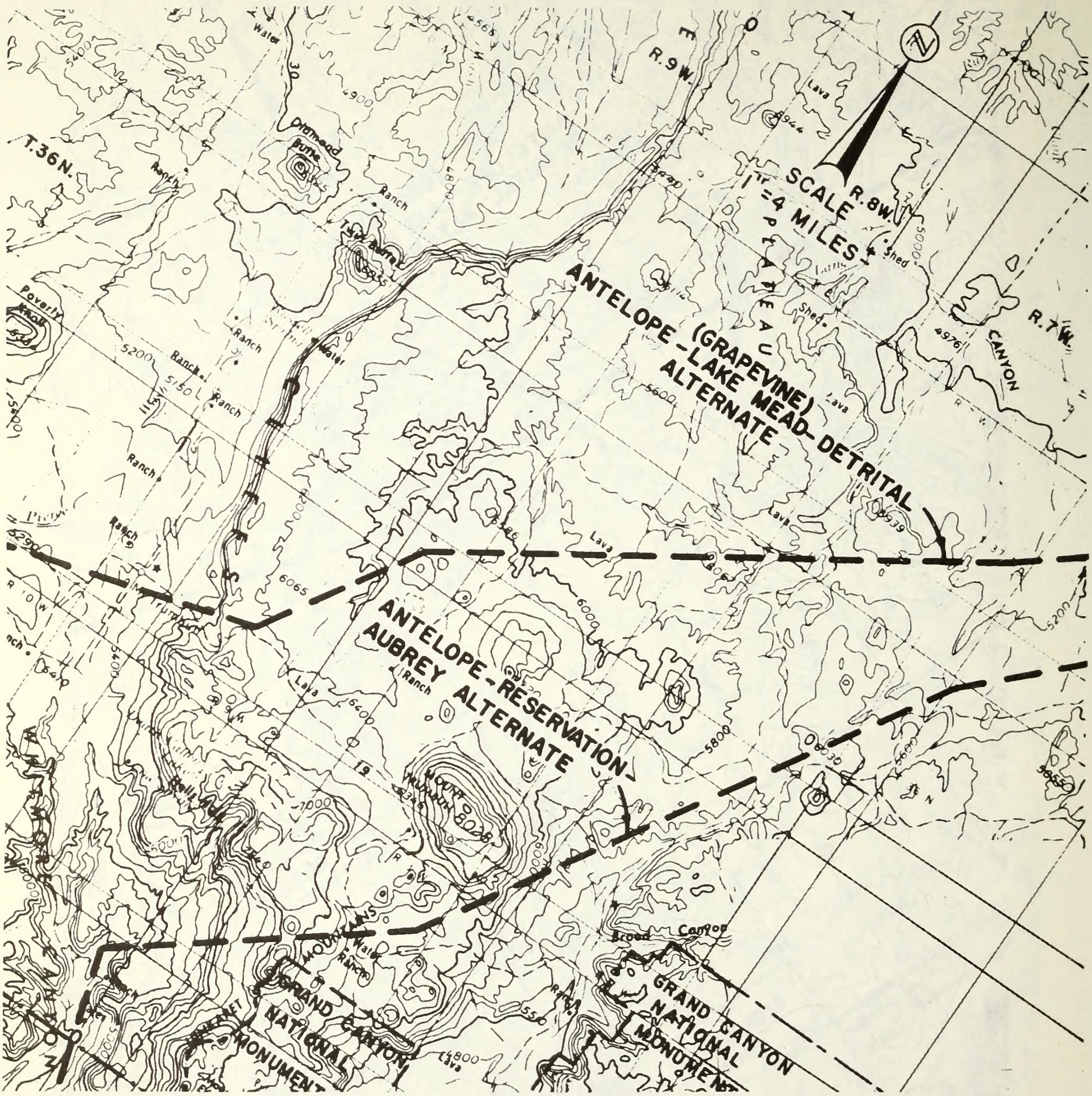


ILLUSTRATION VIII-81

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 24 of 25)

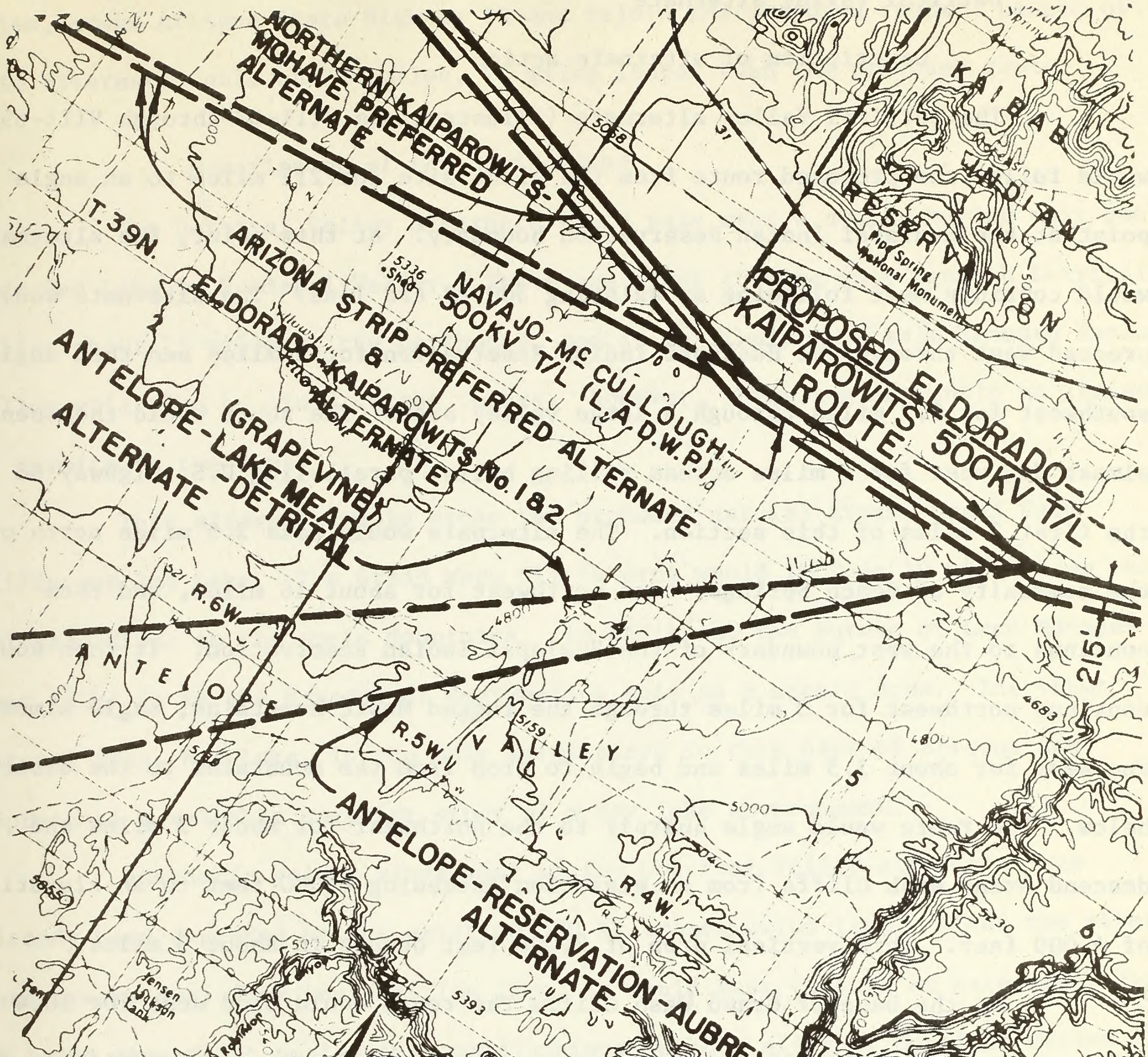


ILLUSTRATION VIII-82

Proposed Kaiparowits Transmission System
Kaiparowits to Moenkopi to Mohave Alternate Routes
(Sheet 25 of 25)

Detrital Valley alternate

Description of alternate action

The Detrital Valley alternate (Illustrations VIII-62 through VIII-69) would follow the proposed route from the plant site for 212 miles to an angle point at the Hualapai Indian Reservation boundary. At this point, the alternate would continue west following an existing 500 kV APS line. The alternate would proceed west through the Hualapai Indian Reservation for 2 miles and then angle southwest for 9.2 miles through a large valley area. The route would then bend almost due west for 9 miles across rolling hills, paralleling U.S. Highway 66 for the first 2 miles of this section. The alternate would pass 2.5 miles north of the community of Peach Springs, turn northwest for about 16 miles, and then continue to the west boundary of the Hualapai Indian Reservation. It then would continue northwest for 3 miles through the rugged Music Mountains, angle almost due west for about 1.5 miles and begin to drop from the mountains to the desert below. The route would angle sharply to the northwest for about 2 miles and descend Grand Wash Cliffs from an elevation exceeding 6,000 feet to an elevation of 4,000 feet. This vertical drop of 2,000 feet occurs in about 3 miles.

At the base of Grand Wash Cliffs the route would bend west for 10.4 miles across Hualapai Valley and then angle southwest for 11 miles, skirting Red Lake. A few miles further west in the White Hills, the alternate would turn southwest and leave the APS line. The alternate would continue southwest for 9 miles, descending the White Hills toward U.S. Highway 93/466 in Detrital Valley. The route would angle farther southwest for about 4.5 miles, cross Detrital Wash and Highway 93/466, and then bend south for 12 miles ascending a long, wide draw that gradually narrows as it gains elevation. The route would jog southwest for about 2 miles, southeast for about 5.5 miles, and descend some steep cliffs to an elevation between 3,500 and 3,600 feet. The route would angle south for 4.6

miles, cross Arizona State Highway 68 and rejoin the proposed route. Length of this alternate would be 328 miles, 20 miles longer than the proposed route.

Description of the environment

The Detrital Valley alternate would pass over a deeply buried salt bed near Red Lake in Hualapai Valley. There are plans to mine salt beneath Detrital Valley about 25 miles to the northwest, and it is likely that salt beneath Hualapai Valley will also be mined in the future. However, there are currently no leases or permits in the area.

This alternate would cross two proposed natural areas, Grand Wash Cliffs and Red Lake. The Grand Wash Cliffs area would include 50 miles from the Colorado River to the Music Mountains. In addition, the Bureau of Land Management (BLM) is in the process of designating this as a scenic area. The other natural area, Red Lake, is the only large playa in this part of Arizona and represents a valuable area for study of a dry lake environment.

Aesthetic values along most of the Detrital Valley alternate have already been degraded by the existing 500 kV transmission line. After the alternate breaks away from the existing line, it would pass through an extensive area of large desert-lot residential subdivisions on both sides of Detrital Valley. Though there is very little opportunity for views of natural desert scenery in the valley or lower hills, higher elevations in the Black Mountain are relatively free of man-made intrusions, and have a greater variety of vegetation and terrain.

Land use along this proposed alternate consists mostly of scattered, acre-estate residences in the White Hills and along both sides of Detrital Valley. Although large parts of Detrital and Hualapai valleys have been subdivided, they are sparsely settled, and it is unlikely these areas will ever be heavily populated.

Land use planning in the area of this alternate is the same as that for the proposed route. Even though an existing line crosses the Grand Wash Cliffs, public opinion expressed through the BLM planning process revealed that no more lines should be built through this area.

Environmental impacts of alternate action

Another power line could restrict or prevent mining of salt beneath part of Hualapai Valley. Along with the existing APS line, construction of this alternate could later require large expenditures by a mining company to relocate the lines or at the very least, could result in a strip several hundred feet wide across Hualapai Valley under which salt could not be mined.

Additional length (20 miles) of this alternate would cause permanent disturbance of 36 acres more of soil and vegetation than the proposed route. However, the alternate would create 7 fewer miles of new corridor.

From the east boundary of the Hualapai Indian Reservation to the White Hills, this alternate would be an additional scenic intrusion. High scenic impacts would occur along the Grand Wash Cliffs. This alternate would also represent a new intrusion along the west side of Detrital Valley. Scenery of the Black Mountains, as viewed from the east, would suffer high impacts because the line would be visible to residents of Detrital Valley and motorists along Highways 68 and 93. The alternate would be more visible than the proposed route since the alternate follows the east side of Detrital Valley for about 25 miles, while the proposed route crosses Detrital Valley for about 12 miles. The alternate could also cause residential property near the line in Detrital Valley to decrease in value.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Detrital Valley alternate could have one of two impacts on future mining of salt in Hualapai Valley: two parallel lines would prevent mining salt beneath a strip several hundred feet wide across the valley; or any company that did mine salt beneath this strip would have to spend large amounts of money to relocate the lines.

Although it would create 7 fewer miles of new corridor than the proposed route, the alternate would permanently disturb an extra 36 acres of soil and vegetation. After mitigation, the line would still reduce scenic quality in Grand Wash Cliffs and along the west edge of Detrital Valley for 25 miles. The proposed route avoids the Grand Wash Cliffs and crosses Detrital Valley for only 12 miles. Finally, a transmission line along this alternate route could cause a decrease in value of residential property near the line in Detrital Valley.

Eldorado Valley alternate

Description of alternate action

The Eldorado Valley alternate (Illustrations VIII-66 through VIII-70) would follow the Detrital Valley alternate to the White Hills. At this point the alternate would continue to parallel the existing APS line across the Black Mountains, Colorado River, and Eldorado Mountains. About 10 miles west of the river the alternate would turn southwest and follow an existing Metropolitan Water District (MWD) 230 kV transmission line through Eldorado Valley to the SCE Mohave-Eldorado 500 kV line about 5 miles north of Searchlight, Nevada. The alternate would then parallel the Edison line to the Mohave generating station. This alternate would be 364 miles, 56 miles longer than the proposed route.

Description of the environment

The Eldorado Valley alternate would cross two areas known to be inhabited by desert bighorn sheep - the Black Mountains and the Eldorado Mountains. Eldorado Valley is crucial habitat for Gila monster and desert tortoise.

Areas surrounding the Colorado River where this alternate would cross have potential for archaeological discoveries. Access to this area is somewhat limited and there is a good chance that existing sites may yet be undisturbed.

The Eldorado Valley alternate would enter Lake Mead National Recreation Area on the west side of the Black Mountains and leave a few miles west of the Colorado River. Landscape in this area consists of rugged, desert scenery, the only intrusion being the existing APS 500 kV line. It has been proposed that lands north of this line within Lake Mead National Recreational Area (NRA) be considered for wilderness area status.

The alternate would cross near Searchlight, Nevada, in Clark County. The population of Searchlight is a few hundred people. The rest of the area is sparsely populated.

Environmental impacts of alternate action

Although the Eldorado Valley alternate would follow an existing line, improved access along the alternate could result in increased harassment of bighorn sheep in the Black and Eldorado mountains and desert tortoise and Gila monsters in Eldorado Valley. The proposed route would avoid the Eldorado Mountains and Eldorado Valley.

Undiscovered archaeological sites along the Colorado River could undergo disturbance during construction of the alternate. In addition improved access to this part of the Colorado River could result in further losses of archaeological sites.

Although there are existing lines the entire length of the proposed alternate, another line would further reduce scenic quality as viewed from boats on Lake Mohave. The alternate would also further reduce natural values of the Lake Mead NRA, which is not crossed by the proposed route.

Construction of this alternate could cause a decrease in residential property values near Searchlight and other areas in Eldorado Valley. On the other hand, construction workers would temporarily increase revenues to Clark County and Searchlight merchants.

Mitigating measures

Grantee would not permanently upgrade existing access in the Black Mountains, Eldorado Mountains, or Eldorado Valley. This measure should protect bighorn sheep, Gila monster, and desert tortoise habitat, and archaeological sites by maintaining restricted access.

Any adverse effects which cannot be avoided should the alternate be implemented

Loss of archaeological sites resulting from construction disturbance could not be entirely mitigated. Construction along the proposed route near the Colorado River would be in a presently disturbed area.

A transmission line along this alternate would be visible to boaters on Lake Mohave. In addition the alternate would reduce natural values of part of the Lake Mead NRA.

A transmission line through Eldorado Valley could cause a decrease in residential property values, especially near Searchlight or other areas that might be subdivided.

Coal slurry alternate

Description of alternate action

The coal slurry alternate (Illustrations VIII-70 through VIII-74) would follow the proposed route to Moenkopi substation. From here the alternate would turn southwest for 35 miles following the APS Navajo to Westwing 500 kV lines. North of Williams the alternate would join the Black Mesa pipe line carrying coal slurry to the Mohave generating station. The route would more or less follow this right-of-way to Seligman. The alternate would meet an APS 230 kV line west of Seligman and continue west, veering away from the existing line, still more or less following the coal line. Near the Cottonwood Mountains, the alternate would meet and follow the Bureau of Reclamation Davis to Prescott 230 kV line and rejoin the proposed route at the base of Cottonwood Cliffs. This route would be 303 miles, 5 miles shorter than the proposed route.

Description of the environment

Much of the coal slurry alternate would cross flat topography that is not unique scenery. This contrasts somewhat with the proposed route which would cross several cliffs or rims and a 30-mile segment of scenic country southwest of Nelson, Arizona. For its entire length this alternate would more or less follow one or more utility rights-of-way.

Environmental impacts of alternate action

For 50 miles northeast of Seligman, the coal slurry alternate would follow the coal slurry pipe line. The alternate would create a new scenic intrusion along this segment. However, most of this segment is relatively inaccessible and would not be viewed by the general public. An exception is Highway 64 between Williams and Grand Canyon. This would be a new crossing of the highway which would result in high impact on scenery. The alternate would also cross Highway

180 between Flagstaff and Grand Canyon, but it would be adjacent to two transmission lines and the addition of a third line would cause little additional scenic impact. This alternate would also be visible from Highway 66 and Interstate 40 near Seligman. Although it would create about 54 miles more of new transmission line corridor than the proposed route, the alternate would more or less follow existing utility rights-of-way its entire length.

Mitigating measures

Same as proposal.

Any adverse effects which cannot be avoided should the alternate be implemented

Scenic impacts at highway crossing cannot be totally mitigated. Although it would create 54 miles more of transmission line corridor than the proposed route, the alternate would more or less follow utility rights-of-way the entire length. The proposed route would cross 32 miles in the Cottonwood Mountains with no utility rights-of-way.

Antelope-Reservation-Aubrey alternate

Description of alternate action

The Antelope-Reservation-Aubrey alternate (Illustrations VIII-78, VIII-81, and VIII-82) would follow the proposed route for 24 miles to the LADWP Navajo to McCullough line and would then turn west along the LADWP line to the proposed Kaiparowits to Eldorado route. The alternate would follow the proposed Kaiparowits to Eldorado route for 40 miles and turn south for 100 miles to rejoin the proposed Kaiparowits to Mohave route near the Hualapai Indian Reservation. The last 100-mile segment was described in the narrative for the Antelope-Hualapai alternate to the proposed Kaiparowits to Phoenix route. The Antelope-Reservation-Aubrey alternate would be 280 miles long.

Description of the environment

The environment along the Antelope-Reservation-Aubrey alternate is the same as the environment along the Antelope-Hualapai alternate to the proposed Kaiparowits to Phoenix route.

Environmental impacts of alternate action

Permanent soil and vegetation losses along the Antelope-Reservation-Aubrey alternate would be about 50 acres less than along the proposed route since the alternate would be 28 miles shorter than the proposed route. However, the alternate would create 70 miles additional new corridor than the proposed route. This new corridor would cross relatively undisturbed lands. Other impacts resulting from this alternate would be identical to the Antelope-Hualapai alternate to the proposed Kaiparowits to Phoenix route.

Mitigating measures

Same as Kaiparowits to Mohave and Kaiparowits to Westwing.

Any adverse effects which cannot be avoided should the alternate be implemented

Construction of a transmission line along the Antelope-Reservation-Aubrey alternate would result in permanent disturbance of about 50 acres fewer than the proposed route; however, the alternate would create about 70 miles more of new corridor than the proposed route. Other unavoidable impacts resulting from this alternate were discussed in the Antelope-Hualapai alternate for the Kaiparowits to Phoenix proposed route.

Antelope-Lake Mead-Detrital alternate

Description of alternate action

The Antelope-Lake Mead-Detrital alternate (Illustrations VIII-68, VIII-69, and VIII-79 through VIII-82) would follow the proposed Kaiparowits to Eldorado

route for 71 miles over the northern Coconino Plateau, and then turn southwest leaving the Kaiparowits to Eldorado route in Antelope Valley directly south of the Kaibab Indian Reservation. After crossing north of Mount Trumbull, the alternate would cross the Hurricane Cliffs and Grand Wash Cliffs, turning south at the base of the latter. The alternate would follow the cliffs, enter the Lake Mead NRA, cross the upper end of Lake Mead, cross Grapevine Mesa, and join the Detrital Valley alternate at the east edge of the White Hills. From here the alternate would follow the Detrital Valley alternate to the Mohave generating station. The Antelope-Lake Mead-Detrital alternate would be 250 miles long.

Description of the environment

The Antelope-Lake Mead-Detrital alternate route would cross 50 miles of pinyon-juniper vegetative community versus 60 miles for the proposed route. South of Lake Mead NRA on Grapevine Mesa it would cross the proposed Joshua Tree Natural Area and desert bighorn sheep habitat. The alternate would cross lands in the Lake Mead NRA that have been proposed for wilderness status. For 125 miles the alternate would cross scenic and undisturbed lands, including the Grand Wash and Hurricane Cliffs and the areas mentioned above.

Environmental impacts of alternate action

The Antelope-Lake Mead-Detrital alternate would reduce the natural, scenic, and possible wilderness values of 125 miles more of undisturbed land than the proposed route. This would include scenic areas such as the Grand Wash and Hurricane Cliffs, a proposed wilderness area within Lake Mead NRA, and a proposed natural area of Joshua tree woodland somewhat unique to Arizona. The alternate would result in permanent disturbance of 104 acres fewer than the proposed route because the alternate would be 58 miles shorter.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

The Antelope-Lake Mead-Detrital alternate would create 125 miles more of new corridor than the proposed route, although it would result in 104 fewer acres permanently disturbed. The alternate would reduce scenic and natural values in a proposed wilderness area, a proposed natural area, and areas of rugged cliffs and rims.

Antelope-Lake Mead-Hualapai alternate

Description of alternate action

The Antelope-Lake Mead-Hualapai alternate (Illustrations VIII-68, VIII-69, and VIII-76) would follow the Antelope-Lake Mead-Detrital alternate to the north end of Hualapai Valley and then turn south along the east edge of the Cerbat Mountains. Six miles north of Kingman this alternate would turn southwest across the south end of the Cerbat Mountains, cross Sacramento Valley and rejoin the proposed route near Secret Pass in the Black Mountains. This route would be 250 miles long.

Description of the environment

The Antelope-Lake Mead-Hualapai alternate would cross parts of northern Hualapai Valley that are underlain by deep salt deposits. This resource was discussed in detail in the Detrital Valley alternate.

The route would cross relatively undisturbed land in Hualapai Valley and the Cerbat Mountains. No lines currently occupy this alternate, and it would not follow utility corridors established through BLM planning. The route would pass several miles north and east of Kingman, Arizona, which appears to be expanding in those directions.

Environmental impacts of alternate action

Impacts resulting from the Detrital Valley and Antelope-Lake Mead-Detrital alternates would also result from the Antelope-Lake Mead-Hualapai alternate. In addition the alternate would create 154 miles more of new transmission line corridor than the proposed route. Surface disturbance would be 104 acres less than on the proposed route because the alternate is 49 miles shorter.

The presence of a power line along this alternate route could reduce land values in areas where future residential development is likely. One such area is north and east of Kingman, Arizona, near the Cerbat Mountains. The other area is located in northern Sacramento Valley which is partially subdivided. At present no homes are actually located along the proposed alternate route.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

In addition to creating 154 miles more of new corridor than the proposed route, the Antelope-Lake Mead-Hualapai alternate would cross an area where utility corridors have been tentatively identified through BLM planning. Permanently disturbed areas resulting from the alternate would be about 104 acres fewer than the proposed route. Transmission lines along the alternate could reduce land values north and east of Kingman and in northern Sacramento Valley. Adverse impacts resulting from the Antelope-Lake Mead-Detrital alternate would also result from the Antelope-Lake Mead-Hualapai alternate.

Impact evaluation

An impact evaluation of all alternate transmission system routes for the proposed Kaiparowits to Moenkopi to Mohave segment is contained in Figure VIII-12.

FIGURE VIII-12

Impact Evaluation of Alternate Routes for Proposed Kaiparowits to Moenkopi to Mohave Route[a]

		Importance to decision making[b]	John Henry Alternate	Cedar Ridge Alternate	Detrital Valley Alternate	Eldorado Valley Alternate	Coal Slurry Alternate	Antelope-Reservation Aubrey Alternate	Antelope-Lake Mead-Detrital Alternate	Antelope-Lake Mead-Hualapai Alternate
Mileage (more or less than proposed route)		5	+3	+ 2	+20	+56	-5	-28	-58	-49
Climate		1	Same as John Henry Alternate of the Kaiparowits-Phoenix Route	N-N	N-N	N-N	N-N	N-N	N-N	N-N
Air Quality		1		S-S	S-S	S-S	S-S	S-S	S-S	S-S
Geology and Topography	General	1		N-N	N-N	N-N	N-N	N-N	N-N	N-N
	Seismology	1		N-N	N-N	N-N	N-N	N-N	N-N	N-N
	Economic geology	3		NN	NM	NM	N-N	N-N	N-N	N-M
Soils	Erosion hazard	5		M-M	M-M	M-M	M-M	M-M	M-M	M-M
	Rehabilitation potential[c]	5		M-M	M-M	M-S	M-M	M-H	M-S	M-S
Water Resources	Quality	5		S-S	S-N	S-S	S-S	S-S	S-S	S-S
	Demand	1		SS	SS	SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	4		S-M	S-M	M-S	S-M	S-M	M-M	M-M
	Acres disturbed (permanent)	6		S-M	S-M	M-S	M-S	S-M	S-M	S-M
	Acres disturbed (temporary)	6		S-M	S-M	M-S	M-S	S-M	S-M	S-M
Wildlife	Terrestrial	9		S-M	S-M	S-H	S-S	M-H	M-H	S-H
	Aquatic	2		S-S	N-N	N-N	N-N	N-N	N-N	N-N
Ecological Interrelationships	Terrestrial	9		S-M	S-M	S-H	S-S	M-H	M-H	S-H
	Aquatic	2		N-N	N-N	N-N	N-N	N-N	N-N	N-N
Paleontology		3		S-M	S-S	S-S	S-S	S-S	M-H	M-H
Archaeology		8		M-M	M-M	S-M	M-M	M-H	M-H	M-H
History		5		M-H	M-M	M-M	S-S	M-H	M-H	M-H
Recreation	General	3		S-S	S-S	M-H	M-M	M-H	M-H	M-H
	Scenic values	6		M-H	M-H	M-H	M-M	S-H	M-H	M-H
	Natural values	6		M-H	M-H	M-H	M-M	S-H	M-H	M-H
Land Uses	Miles of new corridor (more or less than prop.)	10		+24	-7	-22	+56	+70	+131	154
	Wood Products	1		S-S	S-S	S-S	S-S	S-S	S-S	S-N
	Agriculture	1		N-N	N-N	N-N	N-N	N-N	N-N	N-N
Socio-Economic	Housing and services	1		M-M	M-M	M-M	M-M	M-N	M-N	M-N
	Culture and attitudes	5		M-H	M-M	M-M	S-S	M-H	M-H	M-H

[a]Impacts rated as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

[c]This rating is not a comparison of impacts, but instead is a comparison of rehabilitation potentials.

Mohave to Serrano

The proposed Mohave to Serrano alternate routes are shown in Illustrations VIII-83 through VIII-90.

Sheephole Pass alternate

Description of alternate action

The Sheephole Pass alternate (Illustrations VIII-83, VIII-87 and VIII-88) would follow the proposed route from the Mohave generating station for about 28 miles to approximately 3 miles north of Camino substation. The alternate would then leave the proposed route and continue southwest across the MWD 220 kV power line and U.S. Highway 66. Continuing southwest, it would pass through Fenner Valley, crossing the Atchison, Topeka and Santa Fe Railroad right-of-way and pass through Sheephole Pass southwest of the Bullion Mountains. The alternate would then turn west and pass 3 miles north of Twentynine Palms and the Amboy Road to Valley Mountain.

From Twentynine Palms the alternate would continue west for about 22 miles parallel to and approximately 3 miles north of the Twentynine Palms Highway, and 9 miles north of Joshua Tree National Monument. Four miles north of the community of Yucca Valley the alternate would turn south and southwest crossing Pioneertown Road and passing within about 1 mile of Pioneertown. It would then cross Twentynine Palms Highway at the northern end of Morongo Valley, proceed south along the east side of the valley, and after crossing the northwest end of the Little San Bernardino Mountains and Big Morongo Wash, turn west and again cross Twentynine Palms Highway. The alternate would then turn south, cross the highway once again, and rejoin the proposed route at Devers substation. This alternate would be 235 miles long.

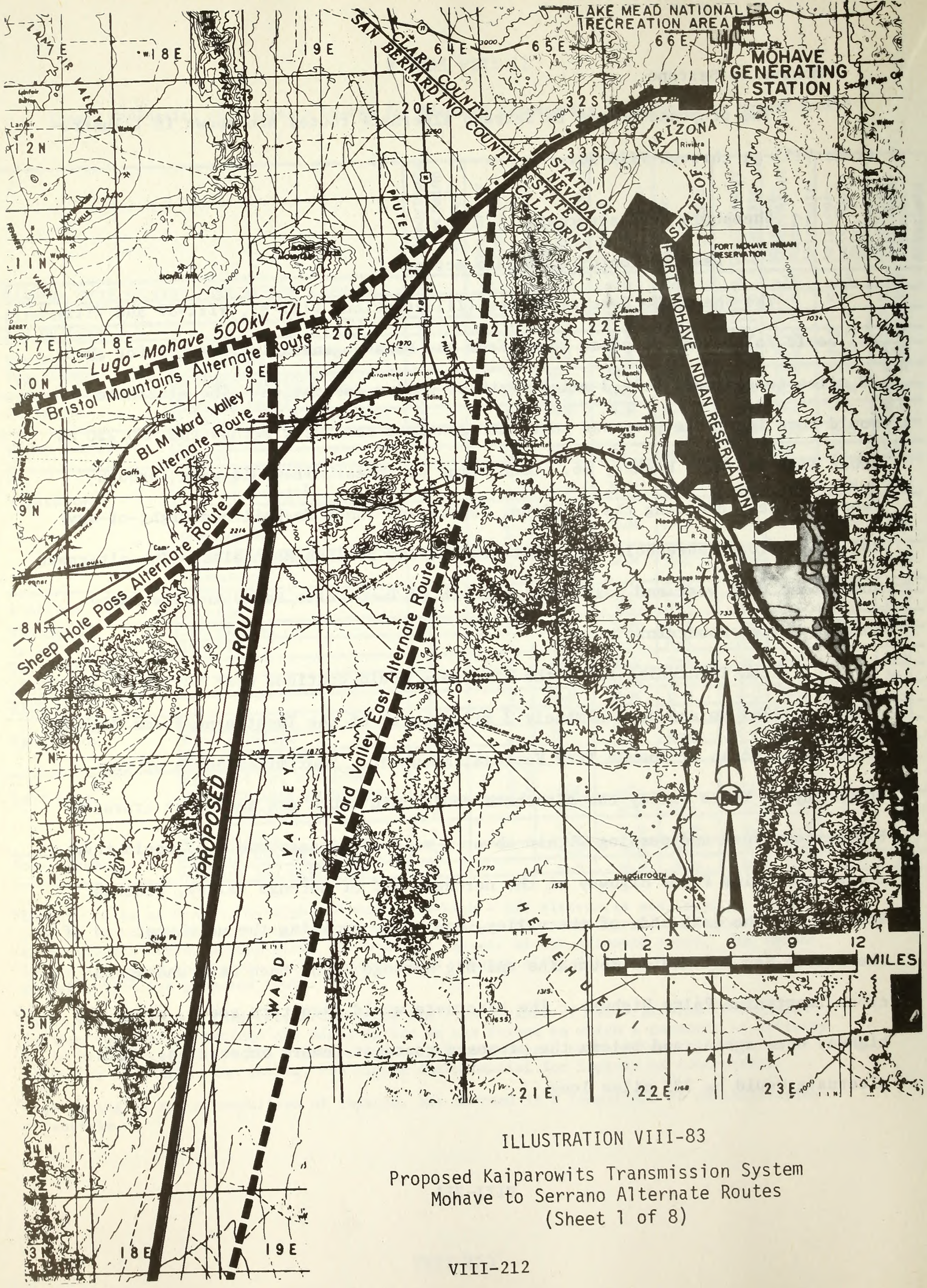


ILLUSTRATION VIII-83

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 1 of 8)

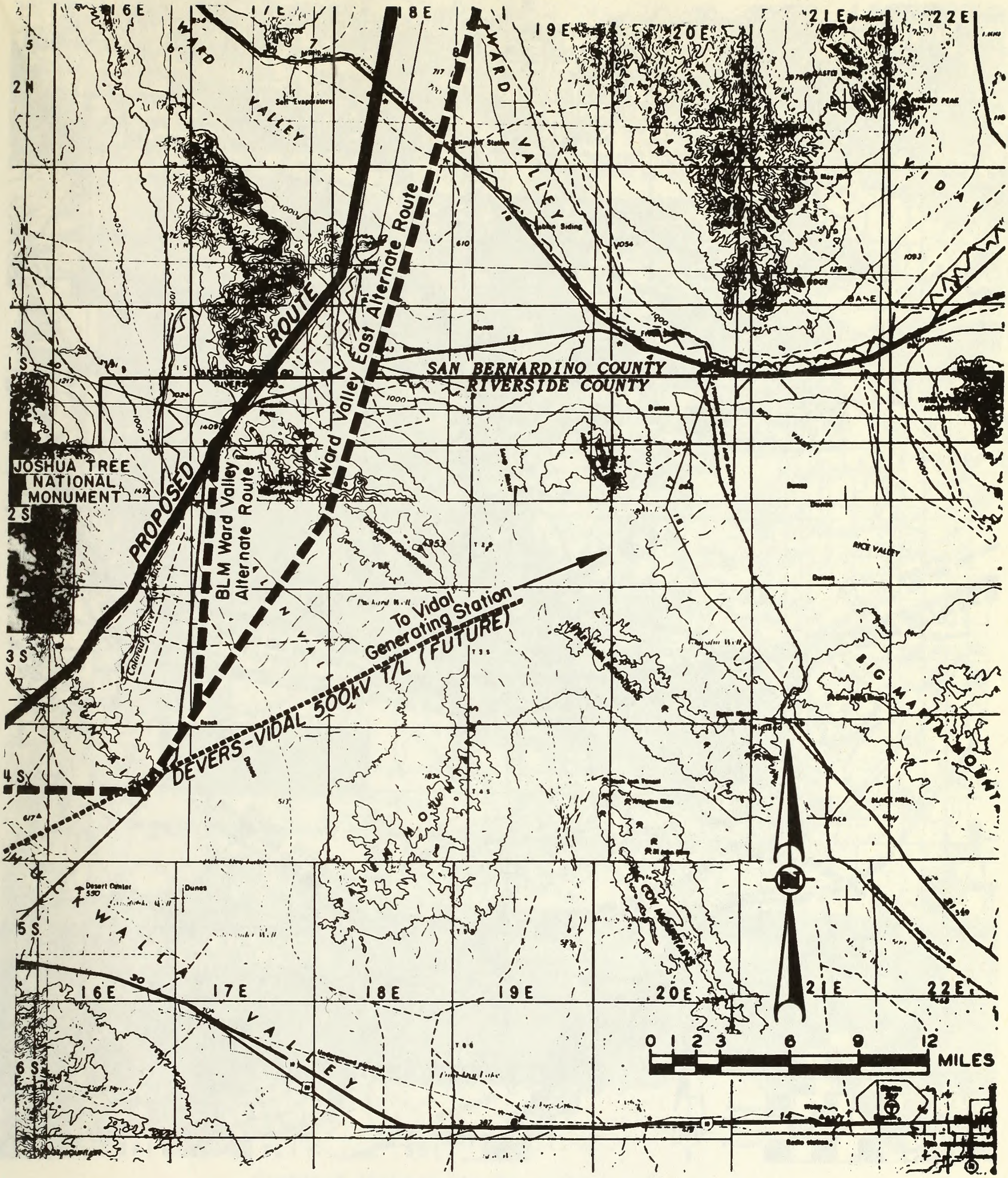


ILLUSTRATION VIII-84

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 2 of 8)

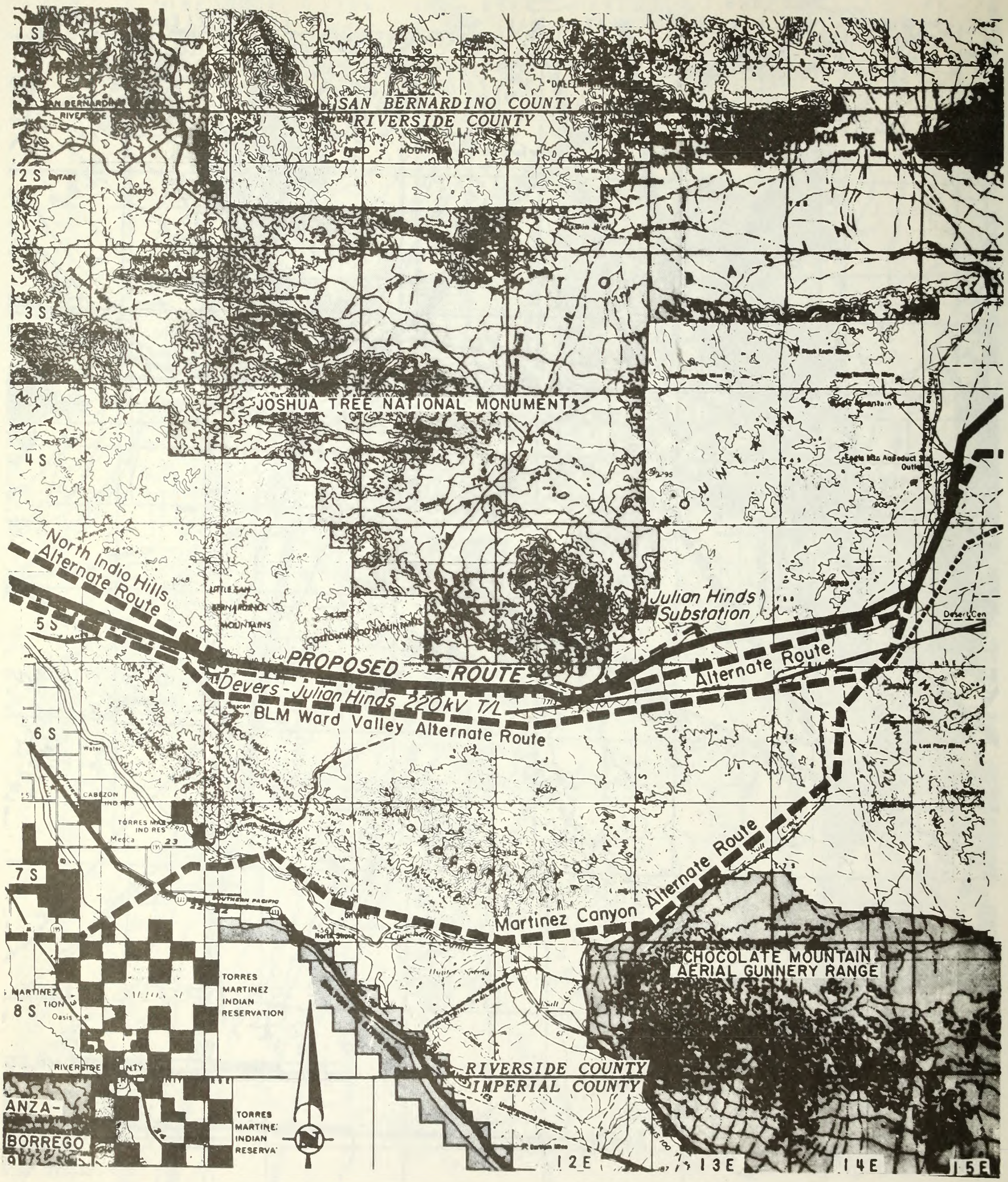


ILLUSTRATION VIII-85

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 3 of 8)

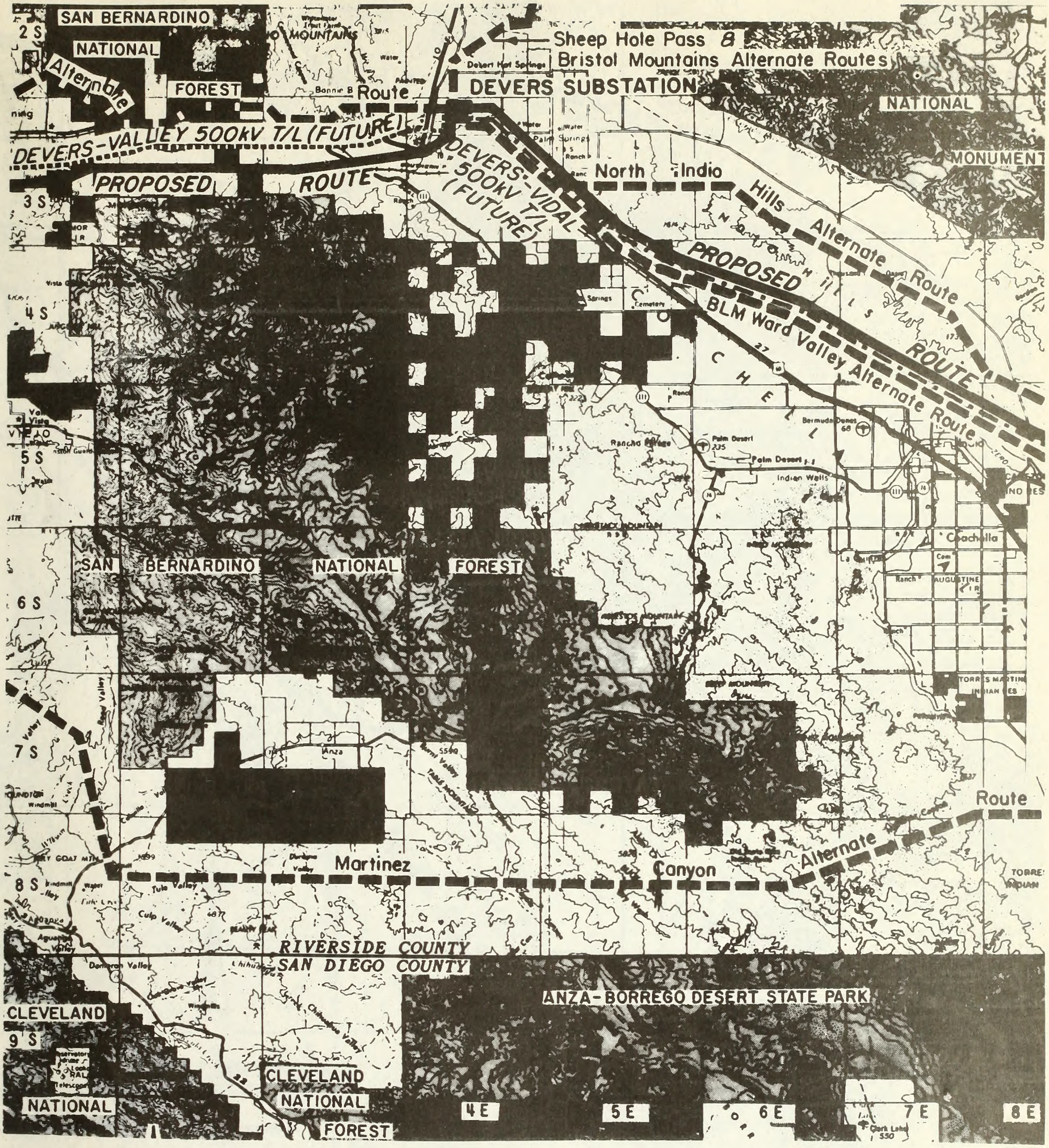


ILLUSTRATION VIII-86

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 4 of 8)

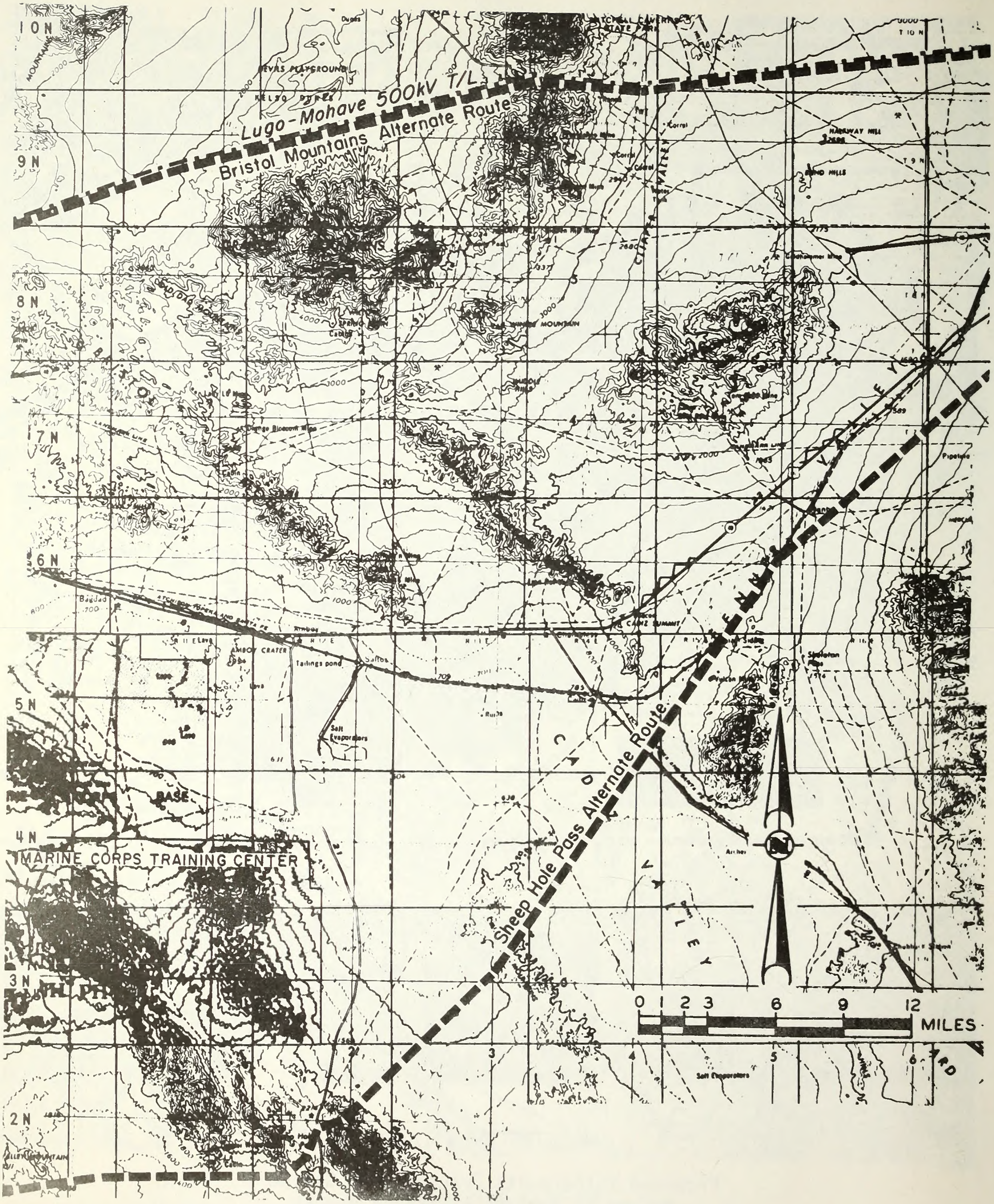


ILLUSTRATION VIII-87

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 5 of 8)

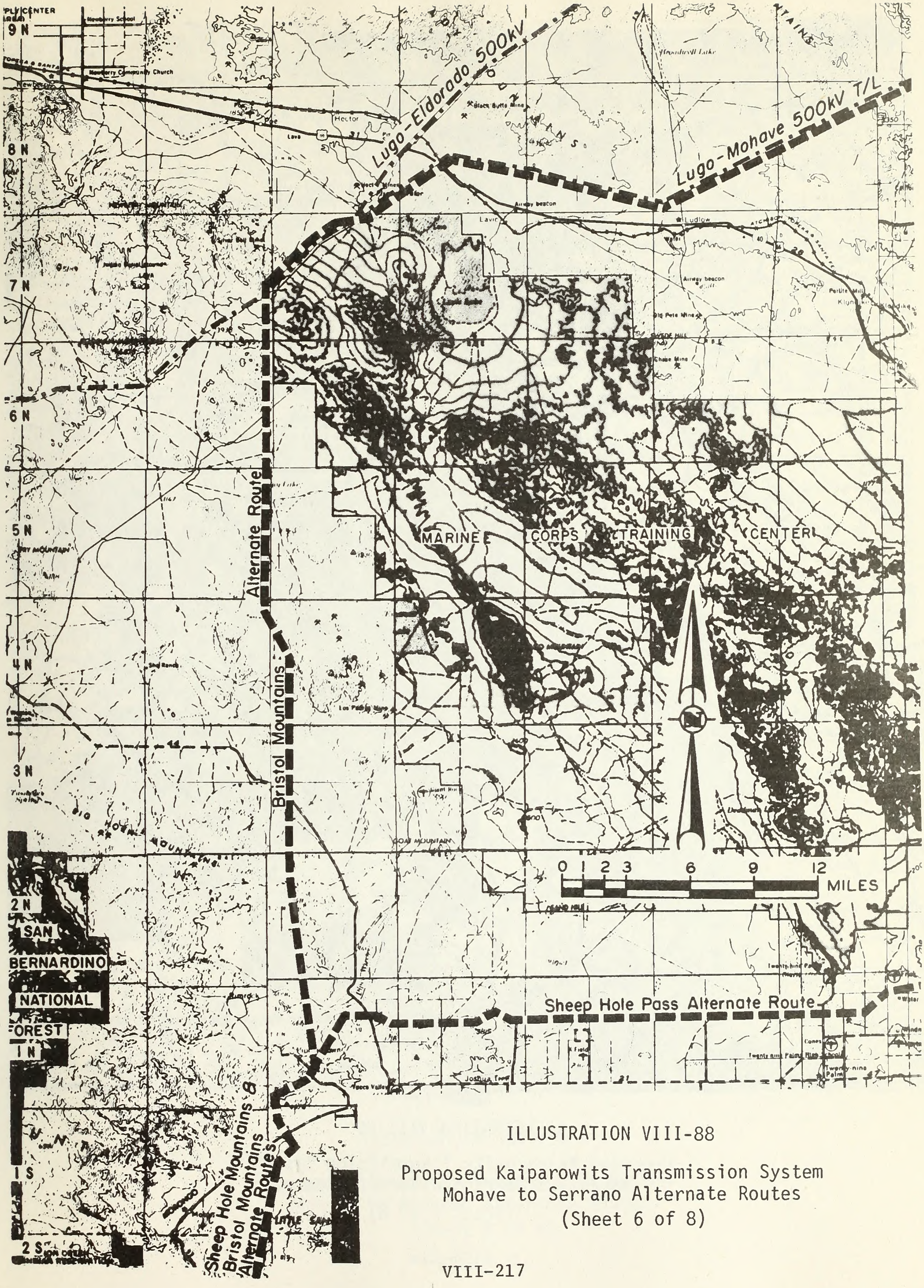


ILLUSTRATION VIII-88

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 6 of 8)

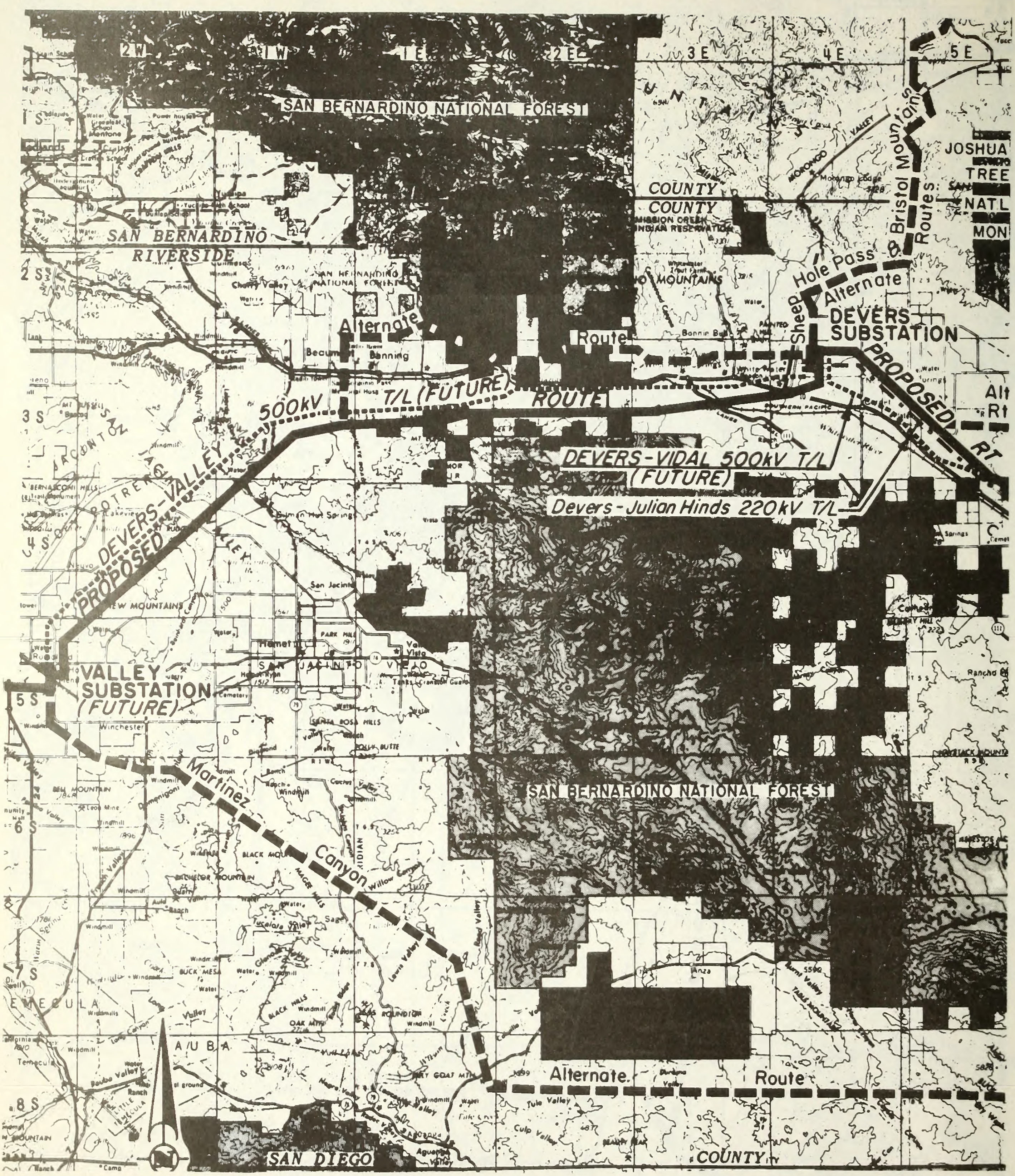


ILLUSTRATION VIII-89

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 7 of 8)

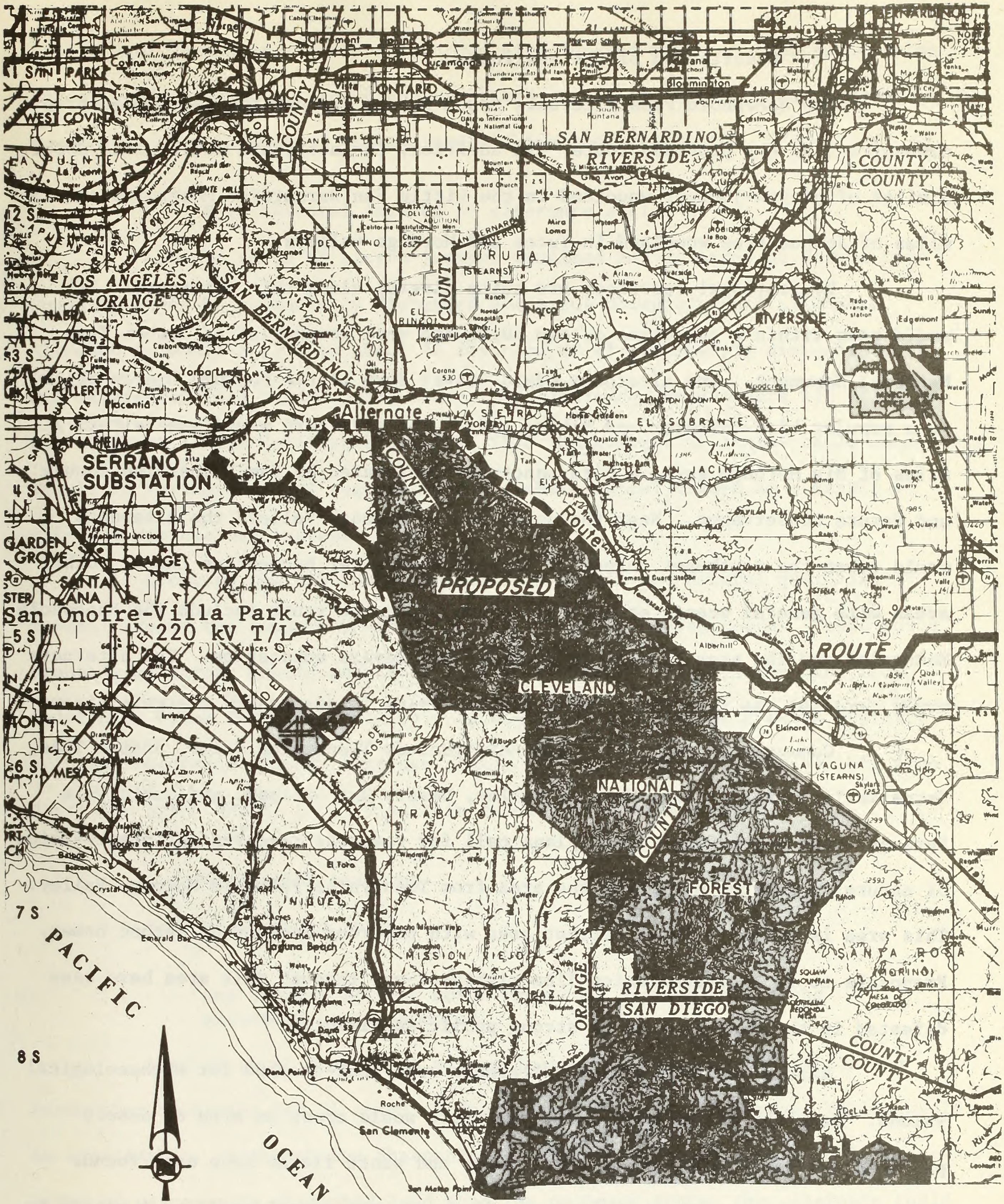


ILLUSTRATION VIII-90

Proposed Kaiparowits Transmission System
Mohave to Serrano Alternate Routes
(Sheet 8 of 8)

Description of the environment

The Sheephole Pass alternate route passes through the same vegetative communities as the proposed route. In addition, the alternate would cross about 5 miles of pinyon-juniper woodland in the Little San Bernardino Mountains and 15 miles of Joshua tree woodland in Yucca and Morongo valleys.

Recreational resources are quite diverse along this alternate. It would pass within a few miles of the north and west boundaries of Joshua Tree National Monument. The alternate would travel down Little Morongo Canyon which is a popular bird-watching and hiking area. The alternate would pass within 2 miles of Big Morongo Park, a bird sanctuary designated by San Bernardino County and Nature Conservancy. Near the north end of Morongo Valley, the alternate would cross the southeast corner of Bighorn-Whitewater Recreation Lands. Other areas with general scenic or natural values along the route include the Sheephole Mountains and the area between Pioneertown and Devers substation. The alternate would parallel the Twentynine Palms Highway which is designated a scenic highway.

Communities near this alternate include Twentynine Palms, Joshua Tree, Yucca Valley, Pioneertown, Morongo Valley, Desert Hot Springs, and North Palm Springs. San Bernardino County plans call for resource reserves and preservation of natural resources except in the area from Twentynine Palms to Morongo Valley. This area is called a rural retreat area with numerous weekend or second homes. Proposals to route transmission line rights-of-way through this area have been defeated in the past because of strong public sentiment.

Random sections of this alternate were spot-checked for archaeological values. Near the Pisgah Lava Beds, the route would cross an area of desert pavement and sandy soils where chert cores and waste flakes have been found. This area is characterized by at least 20 dense concentrations (1 to 4 meters in diameter) of these cultural remains. Such concentrations apparently represent

lithic tool workshops. Another recorded site located north of Twentynine Palms appears to have been a large occupation site; materials noted on the present surface include potsherds, flakes, and milling tool fragments.

Environmental impacts of alternate action

About 4 acres of pinyon-juniper woodland and 11 acres of Joshua tree woodland would be permanently disturbed along the Sheephole Pass alternate. Although it would result in about 24 fewer acres of permanently disturbed soil and vegetation than the proposed route, the alternate would create 125 miles of new corridor in the California desert. This improvement of access could eventually result in further loss of vegetation and archaeological values as a result of off-road vehicle use increase.

Although the alternate could reduce scenic and natural qualities of several areas, the impacts would be similar to the proposed route. There would probably be strong public sentiment against routing a transmission line from Twentynine Palms to Morongo Valley. In addition, the alternate would conflict with San Bernardino County land use plans. The alternate would be visible from developed areas and it could result in reduced land values nearby.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Loss of about 4 acres of pinyon-juniper woodland in the Little San Bernardino Mountains and 11 acres of Joshua tree woodland in Morongo Valley would be unavoidable. Although the Sheephole Pass alternate would result in 24 fewer acres of permanently disturbed land than the proposed route, the alternate could

eventually result in greater losses because it would improve access to the California desert. The alternate would conflict with San Bernardino County land use plans from Twentynine Palms through Morongo Valley and it would conflict with public attitudes in the Twentynine Palms area.

Bristol Mountains alternate

Description of alternate action

The Bristol Mountains alternate (Illustrations VIII-83 and VIII-86 through VIII-89) would follow the proposed route for about 12 miles from the Mohave generating station and then continue southwest parallel to and 2,000 feet south of the Lugo-Mohave 500 kV line. It would cross Piute Valley to an angle point located about 0.5 mile north of Fenner Hill, and then angle west for about 23 miles to the western slope of the Providence Mountains. The alternate would pass about 1 mile south of Mitchell Caverns State Park in these mountains and then bend southwest for about 37 miles. Along this segment, the alternate would skirt Kelso Dunes and cross the Bristol Mountains. About 1 mile northwest of Ludlow, it would turn northwest for 10 miles along the southern end of Cady Mountains.

The alternate would then turn southwest about 0.5 mile north of Pisgah and cross the Atchison, Topeka and Santa Fe Railroad tracks and Interstate 40. The alternate would follow the northwest boundary of the Twentynine Palms Marine Corps Training Center for about 7 miles and then turn south leaving the existing lines and parallel the training center boundary for 4 miles. The alternate would continue south between the Bullion Mountains on the east and Lucerne Valley and the Bighorn Mountains on the west. After 34 miles it would meet and follow the Sheephole Pass alternate. This alternate would be 250 miles long.

Description of the environment

Vegetation along the Bristol Mountains alternate is similar to the proposed route. Exceptions are pinyon-juniper woodland in the Providence Mountains and pinyon-juniper and Joshua tree woodlands described for the Sheephole Pass alternate.

Parts of the route were surveyed for archaeological sites, but none were found. However, the alternate is believed to have approximately the same potential for such values as the proposed route.

Scenic, natural, and recreation values along this alternate are similar to the proposed route and the same as part of the Sheephole Pass alternate. In addition, the Bristol Mountains alternate would cross near Mitchell Canyons State Park in the Providence Mountains and the Kelso Dunes area which is closed to off-road vehicle use. The alternate would also cross Highway I-40 and State Route 247, which are classified as scenic highways in the California State Master Plan.

The discussion of land use planning along the Sheephole Pass alternate also applies to this alternate. In addition San Bernardino County General Plan identifies three areas along this alternate as Recreation-Conservation Areas - the Mitchell Caverns area, the area northwest of the Marine Corps Training Center, and the Bighorn Mountains. However, the alternate would not cross this last area. These areas are described as having large blocks of land, primarily in public ownership, where scenic, wildlife, and recreation values, and their potential for public enjoyment, are superior to other land in the desert portion of San Bernardino County.

Environmental impacts of alternate action

The Bristol Mountains alternate would result in impacts similar to those resulting from the proposed route. Although the alternate would create

about 38 miles more of new corridor than the proposed route, it would result in 11 acres fewer of disturbed soil and vegetation than the proposed route. Construction of the alternate through the Kelso Dunes area would result in improved access into an area closed to off-road vehicles. This could make it more difficult to prevent such use in the area. The alternate would also conflict with San Bernardino County land use plans in the Mitchell Caverns area and the area northwest of the Twentynine Palms Marine Base. However, the alternate would follow existing transmission lines on a 2,000-foot separation through both areas. Impacts on public attitudes discussed for the Sheephole Pass alternate also apply to the Bristol Mountains alternate.

Mitigating measures

After construction were completed, all access roads in the Kelso Dunes area would be obliterated. Maintenance of this segment of the route would be by helicopter only. This measure would ensure that access into the Kelso Dunes area would not be permanently improved.

Any adverse effects which cannot be avoided should the alternate be implemented

The Bristol Mountains alternate could conflict with San Bernardino County land use plans and could temporarily hamper enforcement of off-road vehicle restrictions in the Kelso Dunes area. Otherwise, impacts resulting from the alternate would be similar to those resulting from the proposed route and the Sheephole Pass alternate.

Ward Valley East alternate

Description of alternate action

The Ward Valley East alternate (Illustrations VIII-83 and VIII-84) would follow the proposed route for about 13 miles then depart south across the

east side of Piute Valley to the Sacramento Mountains. It would continue south and southwest for 74 miles through the Sacramento Mountains, the east side of Ward Valley, the Danby Dry Lake area, the Granite Mountains, and Palen Valley. This portion of the alternate would cross U.S. Highways 95 and 66, the Santa Fe Railroad main line to Needles, the Four Corners pipe line right-of-way, the Southern California Gas Company pipe line right-of-way, the Santa Fe Railroad Parker Dam spur track right-of-way near Danby Dry Lake, and the Colorado River Aqueduct near Iron Mountain. The alternate would turn west near the southern tip of the Coxcomb Mountains and cross Chuckwalla Valley for 7 miles. It would then turn to the southwest and proceed for about 13 miles and rejoin the proposed route near the Eagle Mountain Aqueduct station. This alternate would be about 266 miles long.

Description of the environment

The Ward Valley East alternate would more or less parallel the proposed route at a distance of up to 9 miles. Thus, with a few exceptions, the environment along the alternate is similar to the proposed route. The alternate would pass through a proposed natural area in the Sacramento Mountains with a unique stand of Bigelow cholla. This area is closed to off-road vehicles. The alternate would also pass within 1.5 miles of a small airstrip at Iron Mountain pumping plant.

Environmental impacts of alternate action

The Ward Valley East alternate would reduce scenic and natural qualities of a proposed natural area in the Sacramento Mountains. The alternate would be sufficiently remote from the Iron Mountain pumping station that it would have no effect on use of the airstrip. Although the alternate and proposed routes would be nearly the same length, the alternate would create 99 miles more of new

corridor than the proposed route. This would result in proportionately greater disturbance of soils and vegetation.

Mitigating measures

Upon completion of construction, all access roads in the Sacramento Mountains proposed natural area would be obliterated. This would help maintain the remaining natural values after construction of the line.

Any adverse effects which cannot be avoided should the alternate be implemented

The Ward Valley East alternate would result in loss of natural and scenic values in part of the Sacramento Mountains. Even if access roads were obliterated, the alternate could render this area unsuitable as a natural area. The alternate would create 99 miles more of new corridor than the proposed route.

Martinez Canyon alternate

Description of alternate action

The Martinez Canyon alternate (Illustrations VIII-85, VIII-86, and VIII-89) would follow the proposed route to where it would turn west along the south boundary of Joshua Tree National Monument. The alternate would continue southwest to the northwest end of the Chuckwalla Mountains and then proceed south and southwest roughly parallel to the Eagle Mountain Railroad and pass through the Salt Creek area. It would continue west and northwest for about 18 miles around the south side of the Orocopia Mountains, parallel to and north of the Coachella Canal. The alternate would then turn and proceed southwest, cross the canal, angle west for approximately 2 miles, and then turn southwest, crossing State Highway 111. It would turn west into a portion of the Torres Martinez Indian Reservation, cross both Highways 195 and follow Martinez Canyon southwest through the Santa Rosa Mountains. The alternate would then turn west parallel

with and 3 miles north of the Riverside-San Diego County line, and 6 to 10 miles south of the San Bernardino National Forest. During this segment the alternate would cross Nicholias, Alder, Horse, Tule, Terwilliger, and Nance canyons and then Durasna Valley. Continuing west the alternate would pass through Rogers Canyon and cross Tule Valley to the Dry Ranch area. At this point it would angle north, cross State Highway 71, cross Wilson Valley, and then turn northwest to cross Weber Valley, Tucalota Creek, Highway 79, Crown Valley, and then Domenigoni Valley southeast of Winchester. From here the alternate line would angle west to north through several angle points and rejoin the proposed route at Valley substation. This alternate would be approximately 277 miles long.

Description of the environment

The greatest concentration of archaeological sites along any alternate is found in Martinez Canyon. This canyon is reported to be the ancestral home of a clan of the Desert Cahuilla. In addition a known ethnographic village is located in the canyon. Thirty-four archaeological sites have been recorded in the canyon environs. Included were three midden village sites with dense artifact scatters, structure rings, and bedrock milling stones; 20 temporary occupation camps with little or no midden development and fewer artifacts; seven bedrock milling sites; one historic Indian-American camp; one rock shelter; one agave roasting pit; and two trail segments. An archaeological survey has not been completed from Martinez Canyon to Valley substation.

The route would pass through the Salt Creek area lying between the Orocopia Mountains to the west, the Chuckwalla Mountains to the east, and the Chocolate Mountains to the south. This area contains numerous archaeological sites, although significance and interpretive potential have not been determined. The Santa Ana range also contains numerous archaeological sites and evidence of historic Indian habitation.

Portions of the alternate would cross scenic areas in Alder, Horse, Nance, and Tule canyons recently transferred to the California State Park system for incorporation into Anza Borrego Desert State Park. These lands were classified by BLM as suitable for recreation and public purposes. The route would pass through the Santa Rosa Mountains, which is a proposed natural area high in primitive, scenic and wildlife values, most notably bighorn sheep. The alternate would also cross a proposed natural area near Salt Creek.

The alternate route would cross Highways 195 and 86, both of which appear in the California Master Plan for designation as scenic highways; the proposed route would cross neither. Highway 86 has an approximate average daily traffic load of 2,100 vehicles.

Land use is somewhat diverse along this alternate. The alternate would cross agricultural lands in Coachella Valley and scattered parcels of such land from Terwilliger Valley northwest to the Valley substation. Some of these lands produce grapes and citrus crops. The alternate would cross within several miles of North Shores airport at the north end of the Salton Sea, Thermal airport, and two private airstrips in Durasno Valley. Areas of residential development along the alternate would include Coachella Valley, the Anza Terwilliger area, and scattered areas east of Valley substation. Part of the Torres Martinez Indian Reservation in Coachella Valley would be crossed by this alternate.

Environmental impacts of alternate action

Of all the Mohave to Serrano transmission routes suggested, both proposed and alternates, the Martinez Canyon alternate would appear to have the greatest potential impact on archaeological values, especially in the Martinez Canyon and Salt Creek area. Considerable study would be required in order to minimize losses of archaeological values that would result from construction of the line.

There seems little doubt that an additional 77 miles of construction activities associated with this corridor would alter or destroy many irreplaceable sites, ruin the integrity of an archaeological locality, and prevent reconstruction of a region prehistory.

The proposed line would reduce scenic and natural values of proposed natural areas in the Santa Rosa Mountains and near Salt Creek. Bighorn sheep in the Santa Rosa Mountains could be forced to move from part of their habitat because of improved access and subsequent harassment. Passage of the proposed route through Alder, Horse, Nance, and Tule canyon areas could reduce, if not completely nullify, the value of these areas recently added to the California State Park system.

Mitigating measures

All construction from Martinez Canyon west to the Anza area would be accomplished by helicopter only. No new access roads would be constructed in this area. This would help protect archaeological values and bighorn sheep habitat along the route.

Any adverse effects which cannot be avoided should the alternate be implemented

A major difference in impacts between the Martinez Canyon alternate and the proposed route would be the potentially greater losses of archaeological and natural values along the alternate. The alternate would create about 77 miles more of new corridor than the proposed route. It is estimated that 25 percent of this new corridor would pass through areas with dense concentrations of archaeological sites. Although sites that occur along the alternate would be salvaged, irreplaceable losses of data would be unavoidable. Loss of natural values would also be unavoidable in the Santa Rosa Mountains, Salt Creek area, and areas recently added to the California State Park system.

Devers to Serrano alternate

Description of alternate action

The Devers to Serrano alternate (Illustrations VIII-89 and VIII-90) would begin at the southwest corner of Devers substation and proceed west 13.8 miles to a point approximately 500 feet north of Interstate Highway 10 and 2.3 miles east of the city of Banning. This portion of the alternate would cross State Highway 62 just west of Devers substation, the Whitewater River, a secondary road, the Colorado River Aqueduct, and 3 miles of Morongo Indian Reservation land north of Cabazon. This entire segment would be parallel to and 150 feet north of the Devers-Vista 220 kV transmission line located approximately 0.5 mile north of Interstate Highway 10.

From this point the alternate would turn to the northwest and proceed over gently sloping grasslands to an angle point near the junction of Mais Canyon and the San Gorgonio River. The alternate would continue to parallel the 220 kV transmission line corridor and cross an additional 2.5 miles of the Morongo Indian Reservation north of the city of Banning. The alternate route would then turn southwest, cross the San Gorgonio River and Banning Canyon Road, and then proceed 0.8 mile where it would turn west and continue to a point 0.3 mile east of Highland Springs road. It would then turn directly south for 3.6 miles and rejoin the proposed route just east of the Beaumont-Potrero road. The alternate route would cross two streets and Interstate Highway 10 1.5 miles east of the city of Beaumont. From the intersection with the proposed route this alternate would follow the proposed route alignment for 18 miles to Valley substation.

Past Valley substation the alternate route would continue to follow the proposed route for 23 miles until reaching a point on the west side of Temescal Valley. From this point it would depart from the proposed route and continue northwest for 9.3 miles across the eastern foothills and canyons of the Santa Ana

Mountains to the northeast corner of the Cleveland National Forest. The initial 3.2 miles of this segment would cross the national forest, while the remaining 6.1 miles would run just east of the forest boundary. The cities of Corona and El Cerrito would be 1.5 miles northeast of the last portion of this segment. From the northeast corner of the Cleveland National Forest, the alternate route would turn west 3.5 miles through rugged mountainous terrain (elevation 2,200 feet) where it would cross the SCE San Onofre-Chino 220 kV transmission line. It would then proceed 1.7 miles through mountainous terrain to the east side of Gypsum Canyon just south of Riverside Freeway (Highway 91). From Gypsum Canyon the route would turn southwest 3.6 miles through mountainous terrain past Walnut Canyon Reservoir and Weir Canyon and rejoin the proposed route about 2 miles east of Serrano substation. This alternate would be about 270 miles long.

Description of the environment

The first part of the Devers to Serrano alternate that deviates from the proposed route would cross an area of higher elevation. This route would not be as visible from I-10 as the proposed route and it would follow an existing 220 kV line at a 150-foot separation. The alternate would pass through several more miles of the Morongo Indian Reservation and it would pass through Beaumont, California. In addition the alternate would pass near Stoney Bridge airstrip in Mabey Canyon.

The second part of this alternate would skirt the Santa Ana Mountains and pass through 3 miles of Cleveland National Forest. The proposed route would cross through 9 miles of the forest, part of which is a roadless area designated by the Forest Service. The alternate would pass within 2 miles of the cities of Corona and El Cerrito.

Environmental impacts of alternate action

Most impacts resulting from the Devers to Serrano alternate would be the same as those resulting from the proposed route. The alternate would create less surface disturbance than the proposed route since it would follow existing lines on a 150-foot separation for 24 miles more than the proposed route.

The alternate would result in higher visual impacts because it would pass through the outskirts of Beaumont, near Banning, and within 2 miles of Corona and El Cerrito. The proposed route would miss Banning and Beaumont by 3 miles and Corona and El Cerrito by 6 miles. The alternate could reduce property values and limit residential development in these areas. The alternate would reduce scenic values around the north end of the Santa Ana Mountains. The alternate would completely avoid a designated roadless area in the Cleveland National Forest. Finally, the alternate would require that Stoney Bridge airstrip be closed or relocated.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Since the Devers to Serrano alternate would pass through or near the Banning-Beaumont and El Cerrito-Corona areas it could reduce property values and limit residential development in these areas. The proposed route would have less effect on these areas because it would miss both areas by several miles. However, the alternate would follow existing lines through the Banning-Beaumont area. In addition, it would create 56 fewer miles of new corridor than the proposed route. The alternate would also require closure or relocation of the Stoney Bridge airstrip.

BLM Ward Valley alternate

Description of alternate action

The BLM Ward Valley alternate (Illustrations VIII-85 and VIII-86) would follow the proposed route for 11 miles. Rather than following the proposed route to the southwest it would continue along the Bristol Mountains alternate for 11 miles to the MWD 220 kV transmission line. After crossing this line, the alternate would turn south and parallel it, rejoining the proposed route about 2 miles south of the Santa Fe Railroad.

After crossing the highway to Desert Center just west of the Granite Mountains the alternate route would again leave the proposed route and proceed along the east side of the highway. It would follow this route for 11 miles to the Ward Valley East alternate and follow the alternate to the proposed route.

The alternate would continue along the proposed route and then follow the Martinez Canyon alternate for almost 4 miles. After crossing Interstate 10, the alternate would turn west parallel to and up to 1 mile south of the highway. The alternate would follow the highway for 29 miles and then turn northwest for 2 miles and cross Highway 10. After crossing Highway 10, the alternate would follow the south side of the Devers-Julian Hinds transmission line to Devers substation rather than the north side as the proposed route would. This alternate would be 276 miles.

Description of the environment

With few exceptions the environment along the BLM Ward Valley alternate is similar to the proposed route. However, the alternate would not cross the Coxcomb Mountains which is a scenic area. By remaining south of I-10 for 29 miles the alternate would avoid scenic areas along the south boundary of Joshua Tree National Monument. The alternate would also avoid an area of springs and

scenic values in the Indio Hills because it would stay south of the Devers-Julian Hinds transmission line. The proposed route would be north of this existing line.

Environmental impacts of alternate action

Although it would be 9 miles longer and create 22 more miles of new corridor than the proposed route, the BLM Ward Valley alternate would have less impact on scenic areas. The alternate would avoid the Coxcomb Mountains and the area adjacent to Joshua Tree National Monument. In addition, the alternate would avoid possible disturbance of springs in Indio Hills because it would be south of the existing line while the proposed route would be north of the line. Desert wildlife use these springs, and disturbance resulting from construction and improved access could force wildlife to seek other sources of water.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Unavoidable adverse impacts along the BLM Ward Valley alternate route would be similar to the proposed route, except the alternate would avoid areas of high scenic quality in the Coxcomb Mountains, along Joshua Tree National Monument, and Indio Hills. Surface disturbance along either the alternate or proposed route would be nearly the same. The alternate would avoid the possibility of preventing wildlife from using the springs in the Indio Hills.

North Indio Hills alternate

Description of alternate action

The North Indio Hills alternate (Illustrations VIII-85 and VIII-86) would follow the proposed route from Mohave generating station for about 147

miles to a point about 3 miles north of the Mecca Hills near Chiriaco Summit. The alternate route would cross and then parallel the existing SCE Devers-Hayfield (Julian Hinds) 220 kV line for 15 miles, skirting the southern boundary of the Joshua Tree National Monument within the corridor established by the existing line, Colorado River Aqueduct, and the SCE pipe line rights-of-way. All these facilities are parallel with the proposed route.

The alternate route would then leave the proposed route in a northwestern direction and proceed around the southwest toe of the Little San Bernardino Mountains for 11 miles. Continuing northwest, the route would then cross Dillon Road, proceed to the northeastern toe of the Indio Hills, follow the toe for 13 miles, and cross Thousand Palms Canyon road. The alternate would then turn to the west and cross the northern extremities of the Indio Hills and rejoin the proposed route. This alternate would be 267 miles long.

Description of the environment

The existing environment along the North Indio Hills alternate is similar to the proposed route south of the Indio Hills. However, the alternate passes near Thousand Palms County Park and crosses Thousand Palms Canyon which is an area of unique scenery in the Indio Hills. The alternate would also cross or pass near areas of residential development north of the Indio Hills.

Environmental impacts of alternate action

The North Indio Hills alternate would generally result in impacts similar to those resulting from the proposed route south of Indio Hills. In addition, the alternate would reduce scenic qualities of the area around Thousand Palms County Park and Thousand Palms Canyon. The alternate could reduce residential land values along parts of the north side of the hills. The proposed route would not have as much effect on land values because it would avoid developed

areas. Finally, the alternate would produce more overall scenic impact because it would create 34 miles more of new corridor than the proposed route.

Mitigating measures

Same as proposed route.

Any adverse effects which cannot be avoided should the alternate be implemented

Scenic impacts resulting from crossing Thousand Palms County Park and creation of 34 miles of new transmission line corridor could not be completely mitigated. Reduction of scenic quality near areas of residential development could result in decreased land values.

Impact evaluation

An impact evaluation of all proposed alternate transmission system routes for the Mohave to Serrano segment is contained in Figure VIII-13.

Current and voltage levels

The first three alternative levels of voltages could be used to transmit energy produced at the Kaiparowits generating station to the load centers using both alternating current (ac) and direct current (dc) circuits. The last two alternatives could carry the energy produced at Kaiparowits, plus an additional 2,000 MW. The present technology considers that the following alternative ac or dc voltage levels could also be used successfully.

Current	Voltage (kV)	Circuits	Lines
ac	345	4 (3 phase)	4
dc	600	1 Bipole	1
ac	765	1 (3 phase)	1
dc	600	2 Bipole	2
ac	765	2 (3 phase)	2

FIGURE VIII-13

Impact Evaluation of Alternate Routes for Proposed Mohave to Serrano Route[a]

		Importance to decision making[b]	Sheephole Pass	Bristol Mountains	Ward Valley East	Martinez Canyon	Devers Serrano	BLM Ward Valley	North Indio Hills
Mileage (more or less than proposed route)		5	-29	-15	+1	+12	+5	+11	+2
Climate		1	NN	NN	NN	NN	NN	NN	NN
Air Quality		3	SS	SS	SS	SS	SS	SS	SS
Geology and Topography	General	1	SS	SS	SS	SS	SS	SS	SS
	Seismology	2	MM	MM	SS	MM	MM	MM	MM
	Economic geology	1	NN	NN	NN	NN	NN	NN	NN
Soils	Erosion hazard	2	SS	SS	SS	MM	SS	SS	SS
	Rehabilitation potential[c]	1	SS	MM	SS	MM	SS	SS	SS
Water Resources	Quality	2	SS	SS	SS	SS	SS	SS	SS
	Demand	0	SS	SS	SS	SS	SS	SS	SS
Vegetation	Grazing (potential loss of forage)	1	SS	SS	NN	NN	NN	NN	NN
	Acres disturbed (permanent)	3	SS	SS	SS	SS	SS	SS	SS
	Acres disturbed (temporary)	3	SS	SS	SS	SS	SS	SS	SS
Wildlife	Terrestrial	8	MM	MM	MM	MM	MM	MM	MM
	Aquatic	1	NN	NN	NN	SN	SS	SS	SS
Ecological Interrelationships	Terrestrial	8	MM	MM	MM	MM	MM	MM	MM
	Aquatic	1	NN	NN	SN	SS	SS	SS	SS
Paleontology		2	NN	SS	SS	SS	SS	SS	SS
Archaeology		6	SS	SS	SS	SH	SS	SS	SS
History		3	SS	SS	SS	SH	SS	SS	SS
Recreation	General	8	MM	MM	MM	MH	MM	MM	MM
	Scenic values	10	MM	MH	MH	MH	SM	HM	SM
	Natural values	8	MM	MH	MH	MH	MS	MM	SS
Land Uses	Miles of new corridor (more or less than prop.)	8	+125	+38	+99	+77	-56	+12	+34
	Wood Products	0	NS	NS	NN	NN	NN	NN	NN
	Agriculture	2	SS	SS	SS	SS	SS	SS	SS
Socio-Economic	Housing and services	2	+MM	+MS	+M+M	+MS	+M+M	+M+M	+M+M
	Culture and attitudes	4	MH	MH	MM	MS	MH	MM	SM

[a]Impacts rated as N-none; S-slight; M-medium; H-high - All alternates are compared to that part of the proposed route replaced by the alternate. The first letter indicates the impact each resource would undergo along the replaced segment of the proposed route. The second letter indicates the impact each resource would undergo along the alternate where it deviates from the proposed route.

[b]Rated from 1 to 10 - This rating indicates the significance of each resource to decision making. Generally, ratings are based either on the degree to which a resource or activity would be impacted, or on the degree of potential controversy surrounding the resource or activity; the higher the rating, the higher the potential for impacts or controversy.

[c]This rating is not a comparison of impacts, but instead is a comparison of rehabilitation potentials.

A comparison of each of the alternatives listed above is shown in Figure VIII-14. Each alternative is discussed below for environmental impact.

FIGURE VIII-14

Comparison of AC and DC Transmission Voltage Alternatives

Voltage Level	No. T/Ls	Avg Tower Height (ft)	ROW Width (ft)	Conductors Bundles	Conductors No.	Routing
345 kV ac (4 circuits)	4	110	330	2	24	Doubling up of proposed routes
600 kV dc (1 circuit) Bipolar	1	165	200	4	8	Kaiparowits to Mesa substation
765 kV ac (1 circuit)	1	165	250	4	12	Kaiparowits to Moenkopi to Needles to Devers to Serrano
600 kV dc (2 circuits) Bipolar	2	165	each 200	4	16	Kaiparowits to Mesa substation
765 kV ac (2 circuits)	2	165	each 250	4	24	Same route as proposal

Alternating current 345 kV (four circuits)

For this alternative, each proposed 500 kV transmission line would be replaced with two 345 kV transmission lines. It would have six lines going south from the Kaiparowits plant to the Colorado River, crossing near Page, Arizona. From there two would go to the Navajo generating station and four would go on to the Moenkopi substation. From there two would go to Phoenix and two to the Mohave switchyard. From the Mohave switchyard four lines would go to the Devers

substation and on to the Serrano substation. The proposed Kaiparowits to Eldorado line would be replaced with two 345 kV lines between those two points.

The environmental impacts are doubled for land area occupied, surface area disturbed, flora and fauna disturbed or destroyed, archaeological and cultural values disturbed, and aesthetics intruded.

Direct current 600 kV (one circuit)

This alternative could replace two 500 kV ac lines in the western system. It would go from Kaiparowits to Eldorado substation to Mesa (near Rosemead, California). This alternate would cost about $53 million more than the proposal. A prime disadvantage of the dc system is the lack of flexibility for power distribution between the beginning and termination point. Although towers are not considered to be as massive, they are taller (165 feet). The advantage of this alternate is the need for only one line. This system can be undergrounded for reasonable distances (i.e., under freeways, etc.). Thus the overall impact on the environment is considered to be less than for the proposal.

There was found to be no significant reliability difference between this system and the proposal.

Alternating current 765 kV (one circuit)

This alternative would have the ability to carry all the energy for the western participants from plant to load center. It would go from the generating plant to Moenkopi substation to Needles substation to Devers and to Serrano. Beneficial environmental impacts would be: the disturbance of one-half of the flora and fauna; disturbance of one-half of the surface; reduction of one-half of cultural and archaeological impacts; and preservation of visual values for the Kaiparowits to Eldorado segment.

Adverse effects of this alternative are higher costs, and adverse visual pollution because of higher, more massive towers.

The proponents do not consider this an acceptable alternative because of the severe problem of reliability with one circuit.

Direct current 600 kV (two circuits)

This alternative may be capable of carrying all energy produced at the Kaiparowits generating station for the western system, plus an additional 2,000 MW, should Kaiparowits or any of the other proposed plants in southern Utah be expanded above the proposed level. The transmission lines would occupy the same routes as the proposal for the 500 kV ac system. These lines would be efficient, capable of carrying twice as much power as presently proposed.

Adverse impacts of this alternative are higher towers, less efficiency because of power losses, and considerably higher costs.

Alternating current 765 kV (two circuits)

This alternative may have the capacity to transmit all of the western systems energy produced at the Kaiparowits generating station plus an additional 2,000 MW if available at some time in the future. These lines would traverse the same route as the proposed route. Beneficial environmental impacts would be the same as the double circuit 600 kV dc alternate. Environmental impacts of this alternative would be the additional land required for actual rights-of-way and the massive towers and conductors which would have a greater visual impact. This would be the most costly alternative.

Use of existing transmission systems

Kaiparowits to Phoenix segment

Alternative No. 1

Description of alternate action

For the Kaiparowits to Phoenix segment, beginning near the Navajo power plant, the existing Navajo to Westwing twin 500 kV lines would be used to transport the APS share of the power generated at the proposed Kaiparowits plant. This would require installation of a set of series capacitors at the Navajo switchyard and the Westwing substation.

Description of the environment

The environment for this alternative would be the same as the proposed action for the Kaiparowits to Phoenix route described in Chapter II.

Environmental impacts of alternate action

The environmental impacts of this alternative would be beneficial because no action is proposed; 299 miles of 500 kV power line and three microwave sites would not be built.

Mitigating measures

No mitigating measures would be needed for this alternative.

Any adverse effects which cannot be avoided should the alternate be implemented

No unavoidable adverse effects would occur from this alternative.

Alternative No. 2

Description of alternate action

For the Kaiparowits to Phoenix segment, beginning near the Navajo power plant, the existing Navajo twin 500 kV line on the alignment of the proposed

action could be upgraded to one 765 kV within one 500 kV line left in place, or one of the existing 500 kV lines could be upgraded to double circuit 500 kV towers. This would have the effect of three 500 kV lines and one 300 foot right-of-way. Bureau of Reclamation engineers state that to upgrade the existing line for 765 kV conductor or to double circuit one line, the entire tower system including footings would have to be replaced. Also, if a 765 kV single circuit, self-supporting tower was used, an additional 30 to 50 feet of right-of-way would probably be needed. This is due to the greater mass of this type of tower. Estimates indicate that disassembly of the existing towers and reconstruction of new towers, whether single circuit 765 kV or double circuit 500 kV, would take twice as long as constructing one single circuit 500 kV line. Two hundred and fifty nine miles could be upgraded.

Description of the environment

The environment for this alternative would be the same as the proposed action for the Kaiparowits to Phoenix route described in Chapter II.

Environmental impacts of alternate action

Soil disturbance by this operation would be severe. Most new disturbance would be confined to areas already disturbed from construction of existing lines. Since much of the original revegetation effort was unsuccessful, vegetation disturbance would be minimal and new construction would present an opportunity to do successful revegetation work.

Existing access roads could be used, closed, and revegetated. Impacts on wildlife populations would be minimal compared to having a second right-of-way, and undisturbed areas would not be opened for additional harassment. One right-of-way would have less visual impact than having a second right-of-way in the same general area.

The greater mass of the 765 kV towers, both single and double circuit design requiring larger footings, more concrete, and more massive construction equipment would combine to create more visual impact and soil disturbance. All tower designs except vertical double circuit type would require a wider right-of-way. This would cause some new areas of soil and vegetation disturbance. A 765 kV vertical double circuit tower would require a wider right-of-way and would be a minimum of 180 feet high. Because of its height, this tower would be seen from a greater distance. All 765 kV towers would cause greater visual impacts because of their mass. Systems reliability would be significantly reduced over that provided by two separate rights-of-way. Service to customers would be interrupted while construction was in progress - possibly for a year.

Mitigating measures

The same mitigating measures recommended for the proposed action in Chapter IV would be required for this alternative. Additional mitigating measures would require that all disassembled structural material be recycled and all foundation materials removed from existing towers be disposed of in approved sanitary landfills.

Any adverse effects which cannot be avoided should the alternate be implemented

Essentially the same unavoidable adverse effects would exist for this alternative as for the proposed Kaiparowits to Phoenix route. In addition, there would be increased soil compaction due to use of additional heavy equipment to remove the existing transmission system. Increased soil compaction would decrease the infiltration rate of soil and increase the rate and amount of runoff. The above effects to the soil would reduce the rehabilitation potential. There would be an estimated 11,600 cubic yards of concrete from the existing footings to dispose of in approved sanitary landfills.

Wildlife would be disturbed for a longer period of time because of the removal of existing transmission system and building the new larger system. About 1,250 acres more land would be committed to use because of additional right-of-way width needed for this alternate transmission system. Present service to Phoenix area consumers would be disrupted for up to 1 year, and system reliability would be decreased because one system would be transporting the energy instead of two systems.

Alternative No. 3

Description of alternate action

From Glen Canyon Dam to Pinnacle Peak substation, the Bureau of Reclamation has two parallel 345 kV transmission lines with potential for upgrading. The 345 kV towers would be removed and replaced with twin 500 kV circuits -- one for this alternative and one for the Bureau of Reclamation needs. Since both lines would have to be removed, probably only one line would be inoperable at any one time. Construction time, as described in the proposed action, would increase four times. This alternative would result in the system carrying the present load plus the additional 500 kilovolts. The upgraded transmission line would be 164 miles long.

Description of the environment

A description of the environment is located in this chapter under the Pinnacle Peak alternate.

Environmental impacts of alternate action

Estimated impacts for this alternate would be about 50 percent greater than those identified in Alternative No. 2 above. The additional impact would be caused by disassembly of two existing transmission lines and construction of two 500 kV transmission lines. Since this right-of-way is cleared, some impacts

caused by construction would be minimized even though towers on both lines would be removed and twin 500 kV lines put in their place. This would cause much soil disturbance, but impacts on vegetation would be less. Existing roads could be used and disturbed areas revegetated. There would be an opportunity for reseeding areas that were not successfully revegetated after construction of the existing lines.

There would be an impact on wildlife during the construction phase. However, once construction is completed impacts on wildlife would be no greater than presently experienced. The 500 kV towers (both single circuit) have more mass than 345 kV towers and would create more visual impact. Systems reliability might be reduced for the Bureau of Reclamation system over that provided by the present twin 345 kV lines. There would also be the disruption of service while existing lines were being replaced.

Mitigating measures

The same measures suggested for Alternative No. 2 above would provide the maximum mitigation for this alternate.

Any adverse effects which cannot be avoided should the alternate be implemented

The unavoidable adverse effects for this alternative would be about 50 percent greater than Alternative No. 2, except both alternates would produce about the same visual impacts.

Kaiparowits to Eldorado segment (Alternative No. 4)

Description of alternate action

Beginning at the intersection of the proposed route and existing Los Angeles Department of Water and Power (Navajo to McCullough) transmission line at

Cockscomb Ridge, there would be a possibility for upgrading existing single circuit towers to double circuit towers. Southern California Edison and LADWP could share a single right-of-way for a great distance since McCullough and Eldorado substations are only about .25 mile apart. Existing single circuit 500 kV towers would be completely removed and 500 kV double circuit towers erected in their place. This procedure is described in Alternative No. 2. About 237 miles of existing transmission line could be upgraded.

Description of the environment

A description of the environment along this alternative can be found in Chapter II under the discussion on the Kaiparowits to Eldorado segment.

Environmental impacts of alternate action

The impacts for this alternative would be similar to those discussed in Alternative No. 2. Both lines would have about 237 miles to upgrade. The most significant difference is that Alternative No. 4 would be more remote and not viewed from well-traveled roads as much as No. 2. In addition, it would not cross Indian reservations, thereby avoiding impact upon certain segments of Indian population who oppose transmission lines crossing their lands. For the remaining impacts see description of environmental impact in Alternative No. 2.

Mitigating measures

The same mitigating measures discussed for Alternative No. 2 would apply to this alternative.

Any adverse effects which cannot be avoided should the alternate be implemented

The unavoidable adverse effects described in Alternative No. 2 would apply to this alternative also. The increased width would require an additional

1,150 acres of right-of-way. Double circuit towers are taller and therefore would create increased visual impacts.

Kaiparowits to Mohave segment (Alternative No. 5)

Description of alternate action

This alternative would upgrade one of the existing APS 500 kV lines of the Navajo to Westwing system to double circuit 500 kV towers as far as the Moenkopi substation. From there the existing APS 500 kV line from the Four Corners power plant to Eldorado would be upgraded to a double circuit 500 kV line until it joins the SCE 500 kV Mohave-Eldorado intertie. The latter line could also be double circuited to Mohave switchyard. Methods of disassembly and construction have been described in alternatives discussed above.

Description of the environment

The environment for this alternative has been described in the following sections of this statement. For the Kaiparowits to Moenkopi part, see description of environment for proposed Kaiparowits to Phoenix route in Chapter II. The part from Moenkopi to Hualapai Indian Reservation is covered in the Chapter II discussion of Kaiparowits to Mohave segment. From Hualapai Indian Reservation to Mohave power plant the existing environment is discussed in the Eldorado Valley alternative in this chapter.

Environmental impacts of alternate action

Impacts created by upgrading segments of these 500 kV transmission lines would be about the same as described for proposed or alternative routes mentioned in the above paragraph. Greater impacts would occur for certain environmental components, such as: more severe soil disturbance caused by removal of existing tower footings and longer construction time necessitated by the disassembly

period; longer periods of human presence could be harmful to wildlife; the visual impact would be greater because of larger tower images; the wider right-of-way would require an additional 1,750 acres. There would be a decrease in system reliability, and cost would more than double. Consumers at load centers would be denied electric power while the existing line was removed and replaced by the larger line.

Mitigating measures

The same mitigating measures used for Alternative No. 2 would be adequate for this alternative.

Any adverse effects which cannot be avoided should the alternate be implemented

The unavoidable adverse effects described for Alternative No. 2 would be repeated in the upgrading of these existing lines.

Mohave to Serrano segment

Potential for upgrading existing transmission lines for this segment would be poor. There are large gaps between existing transmission lines that follow the general direction of the Serrano substation from the Mohave power plant. Therefore, upgrading this segment would not be a reasonable alternative.

Underground

Description of alternate action

This alternative would bury proposed transmission lines below the surface. There could be an infinite number of possibilities if only partial burial of the conductors was considered.

There is a marked difference between undergrounding ac and dc systems. Technology for undergrounding ac systems is in an early stage. Presently only

distances of .25 mile or less of 500 kV ac conductor can be undergrounded without intricate oil or inert gas pipe cooling systems. Extra high voltage dc transmission lines (400 kV dc) have been successfully undergrounded for up to 40 miles in other countries. While a 500 kV ac underground cable-pipe system may be technically feasible, costs could be 10 times that of overhead transmission.

Description of the environment

The alternate action would have the same environment as the proposed action.

Environmental impacts of alternate action

The alternate action would disturb 3,500 acres more than the proposal. The effect of deep trenching and additional disturbance would make rehabilitation more difficult. The above effects would also increase the impact to wildlife. Pumping and cooling would require energy from some source, and this would impact our energy supply.

A beneficial impact would be preservation of the visual quality of scenic areas.

Mitigating measures

Mitigating measures for the alternate action would be the same as for those relating to visual impacts associated with towers and overhead transmission lines.

Any adverse effects which cannot be avoided should the alternate be implemented

More acres would be disturbed and rehabilitation would be more difficult. Also, energy would be consumed by operation of pumps and cooling systems. This alternate action would have more unavoidable impacts to natural resources than

the proposed action but would lessen visual impact to areas traversed by the transmission system.

Line spacing

Description of alternate action

The alternate action would not allow 2,000-foot spacing in the three transmission system proposals. This alternate action would grant rights-of-way adjacent to and paralleling existing high voltage transmission lines along proposed routes.

Description of the environment

The alternate action would have the same environment as the proposed action.

Environmental impacts of alternate action

The alternate action with a minimum line spacing would have the same impacts as the proposal, except the quantity of impacts would be reduced. There would be a reduction in total disturbed acres. The following information shows miles of 2,000-foot separation in each proposal and the possible reduction in disturbed acres.

	Miles of 2,000-Foot Separation	Possible Reduction in Disturbed Acres
Primary proposal	468	1,034
Northern Kaiparowits preferred alternate	606	1,236
Arizona Strip preferred alternate	486	1,198

The reduced amount of disturbed acres would lessen the impact to vegetation, soil, wildlife habitat, aesthetics and visual intrusion. In addition, by decreasing the miles of new road built and placing transmission lines closer together there would be fewer areas opened to public access thus reducing possible damage to historical, cultural and archaeological values in the area. From a land management point of view, as observed by large land managers such as U.S. Forest Service, Bureau of Land Management and the Navajo Tribe, the minimal spacing alternative is compatible with good land stewardship practices.

Mitigating measures

The mitigating measures for the alternate action would be the same as for the proposal.

Any adverse effects which cannot be avoided should the alternate be implemented

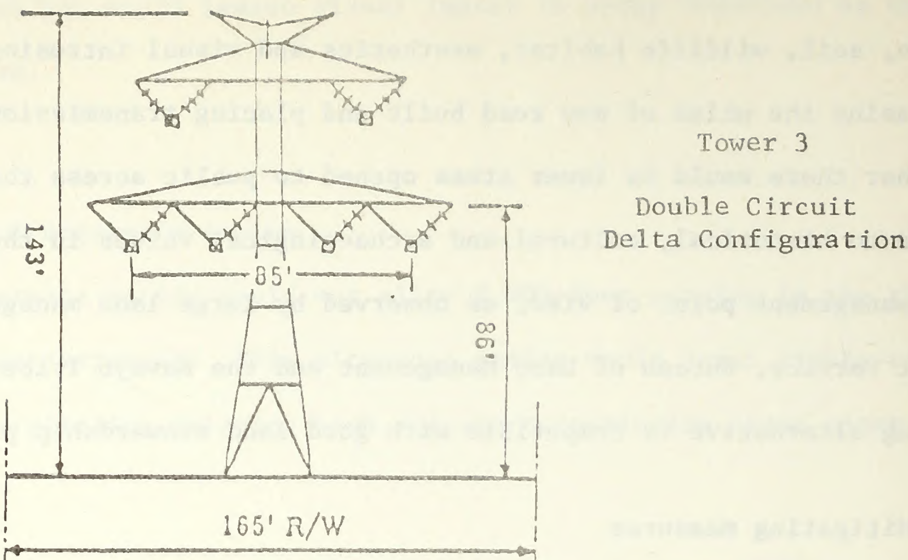
The alternate action would reduce the adverse impacts because there would be fewer acres disturbed and less new access created. Reliability of the system might be reduced due to minimal spacing.

Multiple circuit towers

Description of alternate action

The alternate action would allow the two 500 kV ac transmission lines to be transferred to a single double-circuit tower either of the Delta configuration or Stack configuration (Illustration VIII-91).

This alternate is sometimes advantageous in areas of limited space, especially in heavily urbanized areas. It has special application on the proposed route in the vicinity of Henderson, Nevada, and the Banning Pass area.



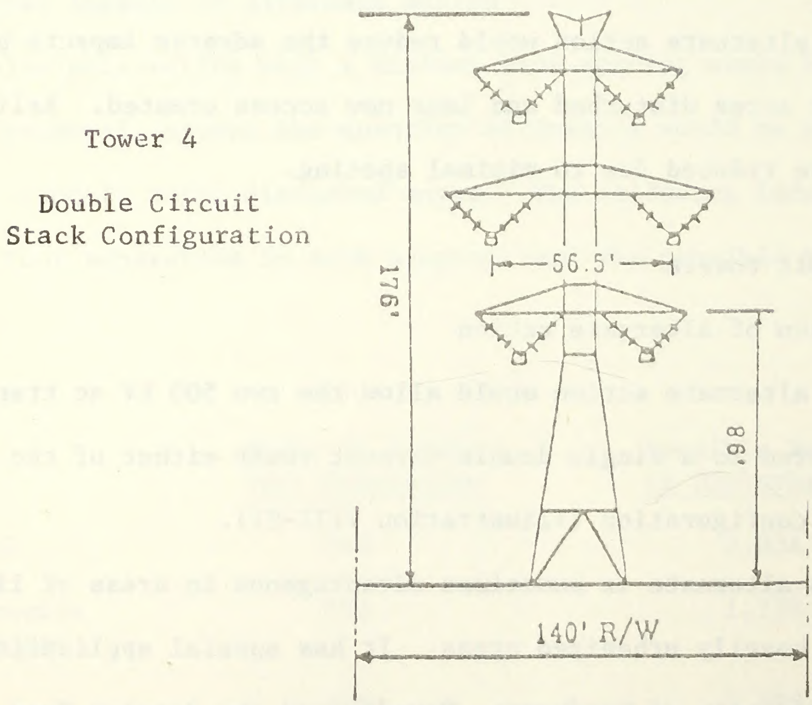


ILLUSTRATION VIII-91

Typical 500,000 Volt Transmission Towers

Environmental impacts of alternate action

The alternate action would have a beneficial impact in terms of substituting one tower for two thus requiring a much narrower right-of-way, 165 feet or 140 feet compared to 330 feet for the proposed. The Delta configuration would be more massive than a single-circuit tower while a Stack tower would be much taller (176 feet) than the proposed (126 feet). This would cause the Stack configuration to have severe aesthetic impacts in most areas. A multiple circuit tower with two lines is less reliable than two tower lines.

Mitigating measures

The mitigating measures would be the same as for the proposal.

Any adverse effects which cannot be avoided should the alternate be implemented

The alternate action would reduce some adverse impacts by narrowing the right-of-way which would disturb fewer acres. The aesthetics of the new towers could be more disturbing because of the massive nature of the double circuit Delta configuration and because of the height of the double circuit Stack configuration. The double circuit system would also result in a decrease in reliability.

Limestone quarry

As discussed in the introduction to this chapter, only technical alternatives are analyzed in this section. Alternate locations are discussed in a later section.

Alternate surface mining methods

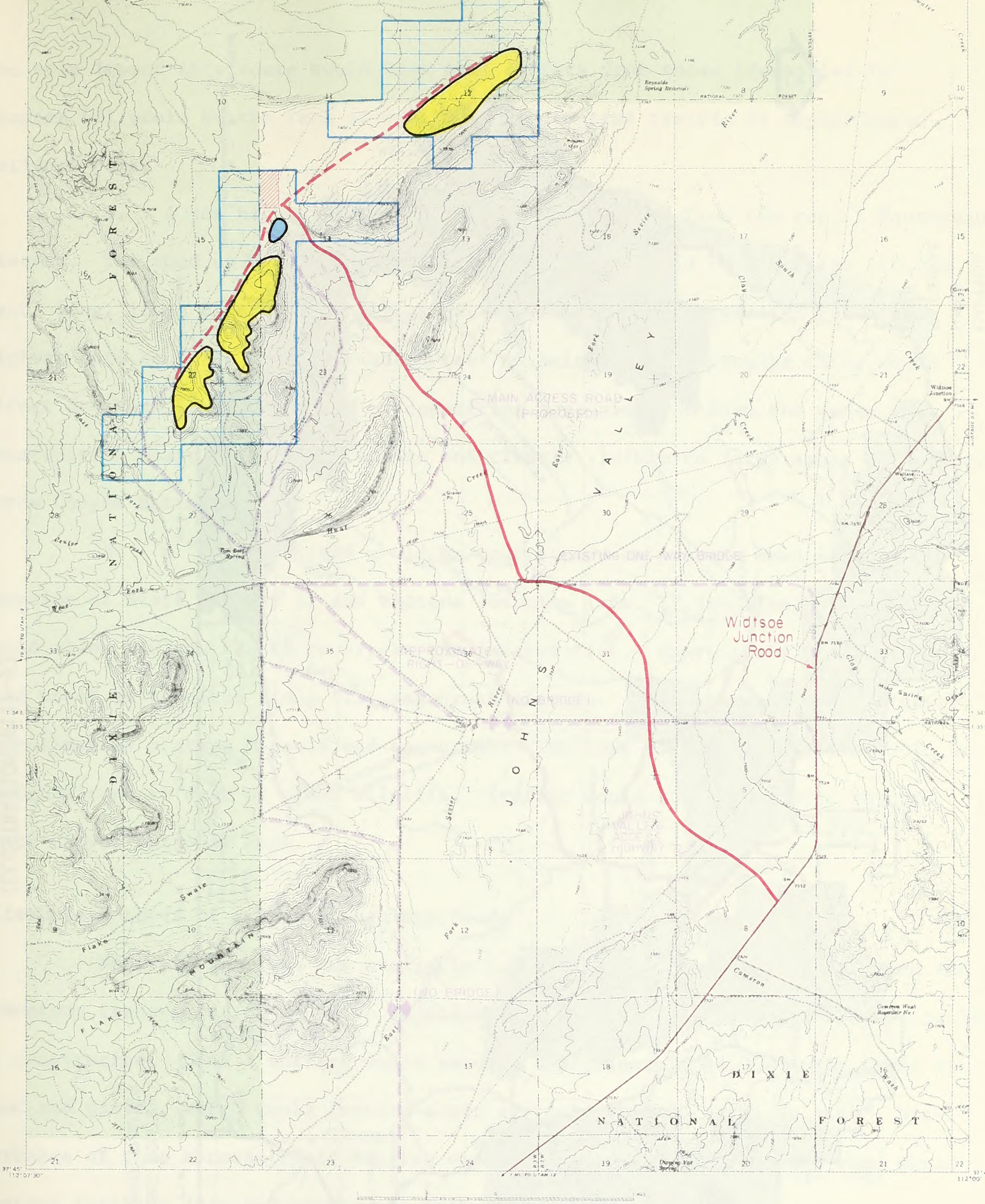
The limestone could be extracted from the quarry by the use of crawl-mounted tractors equipped with rippers, truck-mounted rotary/percussion drill, power shovels, and scrapers. Regardless of the alternative used, impacts to the environment would not be any different than those discussed in Chapter III on the Limestone Quarry.

Alternate access roads and transportation routes

Several alternate access roads to quarry areas are possible. Exact routes would depend upon final design of quarry operation, easements, and environmental considerations. Those alternates which may disturb wildlife, specifically the endangered Utah prairie dog or sage grouse, would not be considered (see Illustration VIII-92).

Three alternate highway haulage routes and variations of the proposed route are available (see Illustration VIII-93). These alternatives include the following:

1. An alternate highway routing would be available by proceeding east from Widtsoe Junction on an existing road. This route climbs the Escalante Mountains then proceeds down Main Canyon until it intersects Utah State Highway 12 several miles west of Escalante. Highway trucks would proceed southwest on Highway 12 to Cannonville, then use the northern access route to Fourmile Bench power plant. This routing would eliminate haulage through Bryce Canyon National Park. However, the summit of Escalante Mountain would require snow removal during winter months.



Quarry Area
Limestone Stockpile
Shop/Office Area
National Forest
Claim and Lease Boundary
Federal Claims
Quarry Main Access Haul Road
Main Access Haul Road (Approx. Right-of-Way)

ILLUSTRATION VIII-92

Alternative Access Routes
to Johns Valley Limestone Project

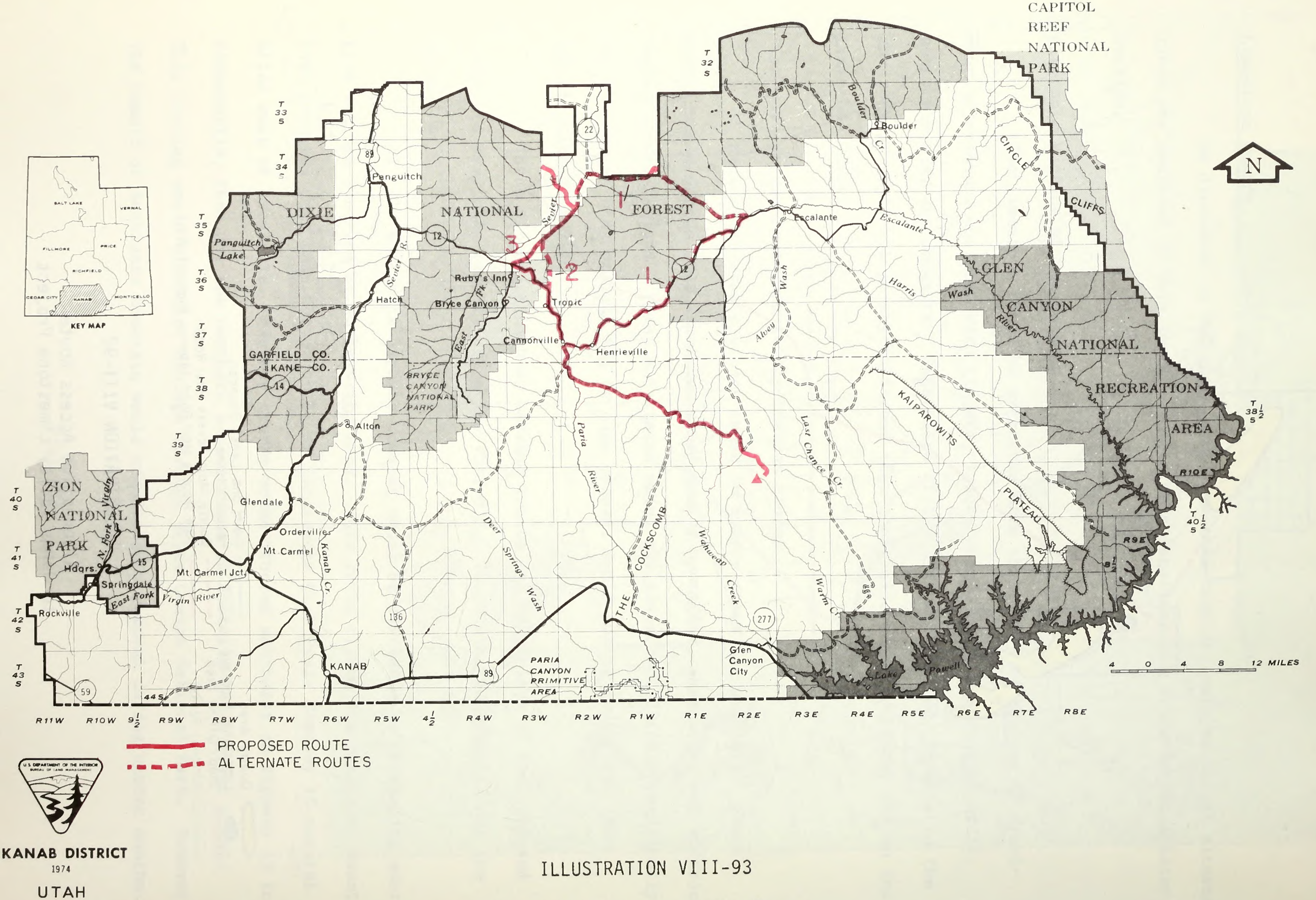


ILLUSTRATION VIII-93

Alternate Transportation Routes

The only impact this route would have that differs from those identified in Chapter III would be the lack of conflict with tourist traffic in Bryce Canyon National Park.

2. A new highway segment could be constructed from the top of Paunsaugunt Plateau. The road up this 1,600-foot high escarpment would be 3.8 miles (20,000 feet) long, if an 8 percent uphill grade is assumed. Highway design for stable highway cuts could be several hundred feet in height, and extensive fills would affect drainage of this plateau by depositing more sediment into the waterway. Construction scars would be extensive and clearly visible to large areas of northern Bryce Canyon National Park.

3. A "cut off" road could be constructed on private land east of the junction of State Highway 12 and Widtsoe Junction (the "Y" junction). The segment would allow haulage trucks to bypass the intersection. Approximately .75 mile of road would be required along flat sagebrush terrain. This approach would disturb approximately 5 acres of soil and sagebrush. The loss of this vegetation would be insignificant to deer or other wildlife. Traffic would still be routed through Bryce Canyon National Park.

Alternate methods of surfacing haulage roads

Many alternatives are available for surfacing unimproved roads along the limestone transportation route to suppress fugitive dust. An asphalt surface could be constructed. Such a surface would require approximately 44,000 cubic yards of sand and gravel, which would require a pit approximately 20 acres in size. Disturbance of this acreage could deprive one deer of forage. An asphalt road would control fugitive dust and provide an all-weather road.

Chlorides of metal could be used (sodium chloride, potassium chloride, and magnesium chloride), to treat the surface to suppress fugitive dust. However, if used over a period of time, these chlorides could develop a cumulative effect

on soils and vegetation causing areas to either support a salt-tolerant vegetation or become barren. The area affected cannot be quantified as it would be dependent on rate and frequency of application and amount of runoff after each storm. This alternative could also result in pollution of ground and surface water.

Alternate methods of transportation

Various systems could be utilized for transportation of limestone. A railroad could be constructed to the power generating facility. Another alternative would be construction of an overland conveyor belt. These transportation systems would require an intensive construction project for approximately 60 miles. These approaches would disturb an additional 400 acres which, in turn, would reduce habitat for approximately 10 to 15 head of deer and increase sedimentation in three different drainages, the Sevier, Paria and Wahweap. Exact amount of sediment increase is not known.

Slurrying and pumping the limestone in a pipeline to Fourmile Bench would be another alternative to truck hauling. The major disadvantage of this system would be the requirement of large quantities of water. Approximately 156,000 gallons per day (175 acre-feet per year) would be required for limestone transportation if 50 percent by weight solids is assumed. Water appropriation would come from the Sevier River drainage and would require purchase of an existing water right, as it is closed to new appropriations. Furthermore, crude limestone would require crushing prior to pipeline transportation thus making it necessary to construct an additional power line to the quarry site. As would be the case with a railroad or overland belt, the slurry line would increase surface disturbance. Also, limestone may be affected by water in the slurry, causing a reduction in its binding characteristics and lowering its effectiveness in SO_2 scrubbers.

Alternate methods of legal disposal

There are two possible methods of disposal of limestone on federal land depending upon whether the limestone is a "common" or "uncommon" variety (as defined under Section 3 of the Multiple Surface Use Act of July 23, 1955, and subsequent court decisions). "Uncommon" varieties may be disposed of by the staking of a mining claim by a qualified party under the Mining Law of May 10, 1872, as amended. "Common" varieties can be disposed of by the federal agency having jurisdiction, only by sale under the Mineral Material Sales Act of July 31, 1947, as amended. A court decision may be needed to determine if the limestone in question is "common" or "uncommon."

Minerals of all types under state jurisdiction can be disposed of only by state mineral lease.

Regardless of which approach is used to dispose of the limestone, impacts to the environment would be the same as those discussed in Chapter III.

Implementation alternatives

Generating plant construction

Access

An alternate route for site preparation and construction equipment during initial entry to the site would be from U.S. Highway 89 north on Cottonwood Canyon road to its intersection with Grosvenor Arch road, then east to the Fourmile Bench site. This route differs from the primary proposal only in the use of the Cottonwood Canyon road from U.S. 89 to the vicinity of Grosvenor Arch.

This section of road from U.S. 89 to Cannonville receives moderate use by local residents and recreationists due to the presence of Kodachrome Basin State Park, Grosvenor Arch scenic area, and cattle operations in the area. It also provides a shorter route to Bryce Canyon National Park for travelers from the south.

The southern part of the road is narrower, longer and generally in poorer condition than the northern segment. Transporting heavy wide loads would conflict with present uses and possibly become a hazard to vehicle operators. All other impacts would be the same as those described in Chapter III.

Construction water source alternatives

A temporary construction water line alternate route would be adjacent to the southern access road beginning at Glen Canyon City. The pipe line would intersect the road at the lower end of Nipple Creek Canyon and follow it to the plant site.

Alternate sources of construction water include the Wahweap arm of Lake Powell, and wells drilled near the plant site. Impoundment of stream water near the plant site would not provide adequate quantities of construction water.

Geological survey studies and coal exploration drilling have not located well water in quantities required for plant site construction. However,

the basin area of Wahweap Creek north of Glen Canyon City is a proven well water area, and wells could be developed there as an alternate source for construction water. Navajo Sandstone, which is the water-bearing zone, is considered part of the water storage of Lake Powell and wells in this area could require a water contract. The construction water pipe line could be an insulated aboveground line in some or all of its route rather than being buried. This would create a visual impact until the permanent line was installed and the construction line removed.

Regardless of the alternative used the impacts would be the same as those described in Chapter III.

Coal mine construction

One alternative to the proposed construction method would be a modular design concept, i.e., to construct a sufficient central facility each year to handle one operating mine. At the end of the second year, when the second mine would be developed, one additional module would be constructed to support the additional operation. Common facilities would be expanded over a 4-year period to meet full production of all four mines. It is proposed that each module would be the same design. Impacts of this alternative would be similar to those discussed in Chapter III for the proposal.

A second alternative would involve staffing of construction projects. In the event a sufficient underground mining force were available, it might be possible that miners could develop the second, third and fourth mines. This would eliminate the necessity of hiring an outside contractor for these projects. However, problems of providing living quarters during the initial construction phase would be the same as described in Chapter III.

An alternative to conventional shaft-sinking methods would be to bore some or all of the ventilation shafts. This method involves rotary drilling of a

small-diameter pilot hole the full length of the shaft. If underground access is available, the pilot hole could be reamed with raise-boring equipment to produce a hole several feet in diameter. Sinking crews could then drill and blast rock into the reamed hole, and eliminate the "mucking" step from the production cycle.

Full boring could be accomplished using heavy-duty rotary equipment. A boring machine would be used to cut the shaft to full diameter. Cuttings removal would be achieved by reverse circulation of drilling mud. A casing would be installed for ground support.

Impacts from drilling a small diameter pilot hole the full length of ventilation shafts or using heavy-duty rotary equipment would be the same as those already identified in Chapter III.

Transmission system construction

A variety of equipment types and construction techniques could be considered for the transmission line structural systems. If guyed towers are used, the helicopter would be a useful item of construction equipment for tower erection, providing component weights can be kept within lift limits. The use of helicopters would reduce disturbance to soils and vegetation by reducing the number of access roads.

Another solution to having a large temporary construction force would be to coordinate skills between various Kaiparowits project participants and components. This envisions that contractors, mine operators, and construction schedules be coordinated so various skills could be utilized by the various parties. This method would require a minimum force of temporary construction workers. Problems of providing accommodations for living space during peak periods of employment would be greatly reduced. Social impacts would be reduced. The amount of reduction is not known at this time.

Capacity greater than 3,000 megawatts (MW)

Sufficient coal and land resources are available to support additional power generating increments at the Kaiparowits site. Additional units at Kaiparowit are not currently planned but participants recognize that availability of these resources supports future feasibility studies for generation beyond the 3,000 MW level. Because lead time for development of coal-fired facilities is approximately 8 years, firm decisions regarding additional facilities for operation in the mid or late 1980s can be deferred for 2 or 3 years. At an appropriate time, depending upon system load growth, availability of other fuels, technological developments, economic feasibility including capital availability, and the overall national interest, the participants would consider Kaiparowits as a site for future generatio An environmental impact statement would be required for any such proposal. However, if the Secretary of the Interior, acting in the national interest, chooses to implement the alternative for increased capacity as discussed in this section, the participants would be receptive.

Potential air quality effects which would result from the alternative of increasing generating capacity above the proposed 3,000 MW were evaluated by the participants. This evaluation determined whether specific increments of generating capacity above 3,000 MW would satisfy the most restrictive air quality standard. Several meteorological plume dispersion conditions were analyzed to determine the specific condition or combination of conditions which would result in the maximum short term and annual average ground level concentrations from the station. Based on information provided, compliance with the 3-hour sulfur dioxide standard would be the limiting air quality factor regarding dispersion of emissions from Fourmile Bench.

Having determined the limiting air quality standard, a maximum site capacity could be calculated that would not exceed this standard. The particpants assumed that additional megawatt capacity would be added in increments of 3,000

MW with the same emission control efficiencies as proposed units. The first increment would be built at right angles to the proposed 3,000 MW. The addition of two more increments, for a total site capacity of 12,000 MW, could be built by completing the square. Additional increments could also be added.

Results of site capacity calculations are given in Figure VIII-15. Based on this evaluation, the participants found that up to 25,000 MW capacity could be built at the site without significant danger of exceeding the limiting 3-hour sulfur dioxide standard. Compliance with remaining standards at higher megawatt capacities could also be accomplished since relation between expected ground level concentrations and the standard would be better than the limiting factor of the 24-hour SO_2 standard. If an adjacent area was redesignated Class I under the Significant Deterioration Regulations, the above would not be true. It is probable that Class I limitations would be exceeded.

FIGURE VIII-15

Site Capacity Predictions[a]

Megawatt Capacity	Maximum SO_2 Emission (g/s)	Estimated 3-hour Maximum Ground-Level SO_2 Concentration ($\mu g/m^3$)
3,000	565	187
6,000	1,130	326
12,000	2,260	617
24,000	4,520	1,194
27,000	5,005	1,333

[a]Based on compliance with the most limiting 3-hour SO_2 Environmental Protection Agency air quality standard.

Many factors and assumptions have been built into these calculations, and extensive additional meteorological and air quality data would have to be collected and analyzed prior to actual construction of any additional generating capacity. Concentrations provided above, however, represent the best conservative estimate presently available.

If the generating capacity of the proposed power plant were increased to 6,000 MW, it would require approximately 24 million tons of raw coal per year. Doubling the number of mines would not achieve the additional coal production required. Multiple-seam mining would require operation of several additional mines and more sophisticated mine planning and scheduling would be required. In the absence of detailed mining plans, it is estimated that ten or as many as twelve mines would be required to meet the higher generating capacity at the Kaiparowits site.

Water quality impact differences between a 3,000 MW plant and a 6,000 MW plant would be increased diversion of water from Lake Powell, larger salt depositions from cooling tower drift, and increased trace elements in runoff.

Salt deposition from cooling tower drift would increase from approximately 1,812 tons per year to 3,624 tons.

Withdrawal of 102,000 acre-feet of water per year from Lake Powell would increase the salinity of the Colorado River at Lee's Ferry, Arizona, less than 1 milligram per liter. This conclusion is contained in a statement presented by Herbert S. Riesbol to the U.S. Senate Interior and Insular Affairs Committee at hearings on effects of large thermal electric plants on quantity and quality of flows in the Colorado River.

The 102,000 acre-feet of water that would be diverted for possible use at Kaiparowits have been included in future development plans by the State of Utah and the Upper Colorado Region Comprehensive Framework Study. In 1973, consumptive water use of diversions by Utah from the Colorado River system was approximately 680,000 acre-feet out of a total allocation of approximately 1,350,000 acre-feet.

Greater quantities of limestone would be required in rock dusting the coal mines and to mitigate SO_2 emissions from a 6,000 MW power generating facility. Limestone quarrying operations would increase production to approximately 2,200 tons per day. Requirements for manpower, equipment, and highway transportation

would also increase. As production levels increased, there would be a corresponding increase in surface disturbance and excavation.

Illustration VIII-94 shows a conceptual transmission line arrangement and proposed routing for the alternative 6,000 MW Kaiparowits generating station. The following lines represent the "maximum requirement" for 500 kV alternating current expansion from the 3,000 megawatt proposal to the 6,000 megawatt alternative:

1. Kaiparowits - Eldorado
2. Kaiparowits - Moenkopi
3. Moenkopi - Mohave
4. Eldorado - Mira Loma (via Lugo substation)

The Eldorado - Mira Loma (via Lugo) line would parallel existing Eldorado - Lugo and Lugo - Mira Loma lines. All other lines would follow corridors proposed for the 3,000 MW level.

Additional routes are feasible for transmission line construction, however environmental studies have not been made to assess their impact. If additional lines were constructed adjacent to the proposed 3,000 MW lines and proposed access roads utilized, additional impact would be minimized. Where 2,000-foot separation would be required for additional lines, new access roads would be constructed thus increasing the impact. Illustration VIII-94 indicates location of microwave communication sites that would be needed for expansion to the 6,000 MW level.

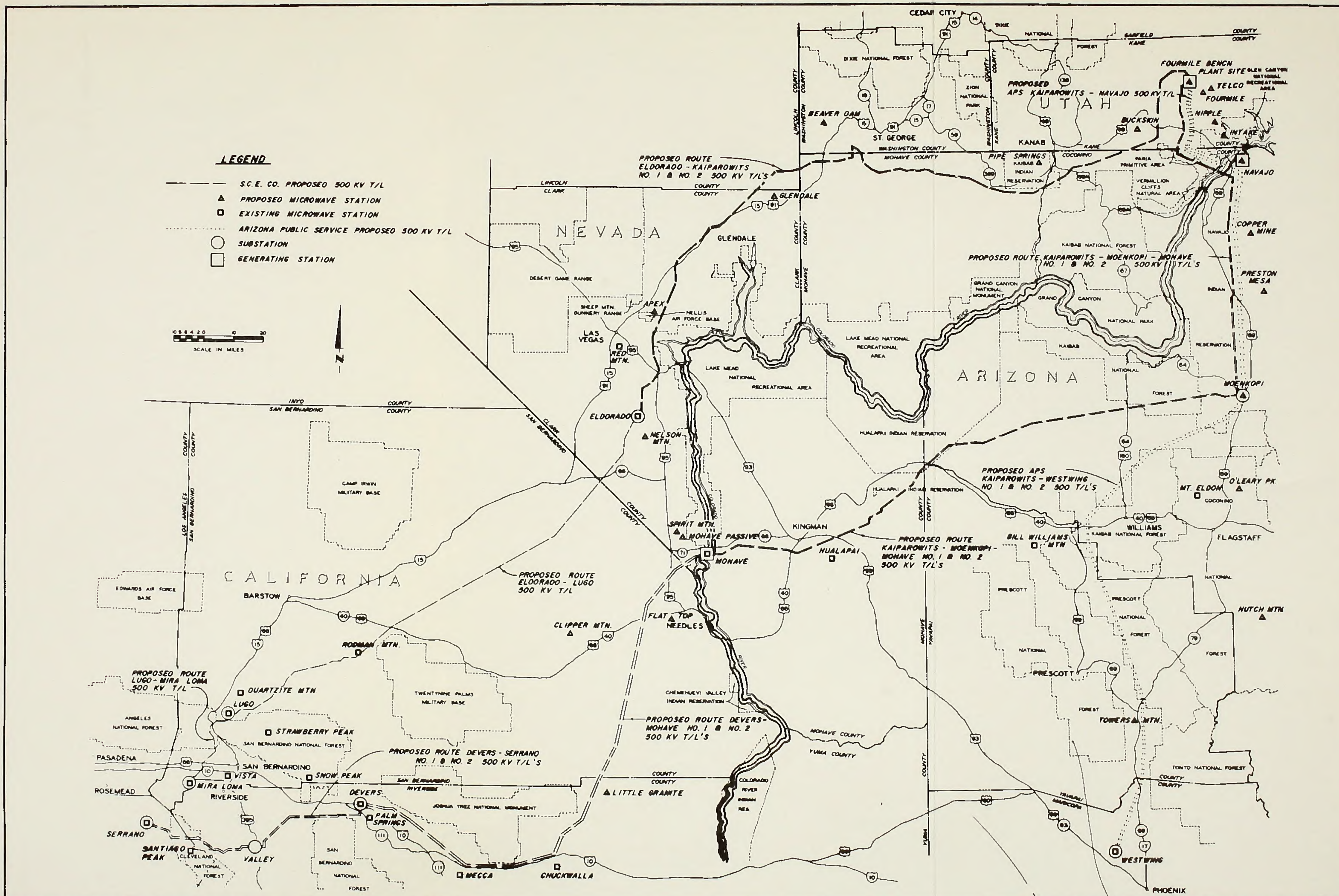


ILLUSTRATION VIII-94

Proposed Transmission System (6,000 MW)
Routes and Microwave Stations

ALTERNATIVE OF CONSTRUCTING PLANT AT NIPPLE BENCH

Description of action

The following section describes only those proposed actions and alternatives for Nipple Bench that would be different from proposed actions and alternatives for Fourmile Bench.

Generating plant

Site arrangement

In order to develop the optimum site layout of the Nipple Bench site, various alternates were considered. Construction and operating constraints were analyzed as well as physical characteristics of the site. The latter include topography, drainage, wind direction, vegetative cover, and archaeological considerations.

Legal description of land included within site boundaries (approximately 4,160 acres) is as follows:

Township 42 South, Range 3 East, Salt Lake Meridian

Section 7: all
Section 8: all
Section 9: all
Section 17: all
Section 18: all
Section 19: N1/2
Section 20: all

The site consists of uneven terrain bordered by several steep-walled canyons on the east and south. A rounded ridge runs east-west through the center of Section 18. The ridge divides in Section 17 into branches which run northeast and southeast. Below this ridge, slopes range up to 5 percent on all sides. To the north, a broad, shallow drainage area runs east to a steep drop-off in Tibbett Canyon east of the proposed site.

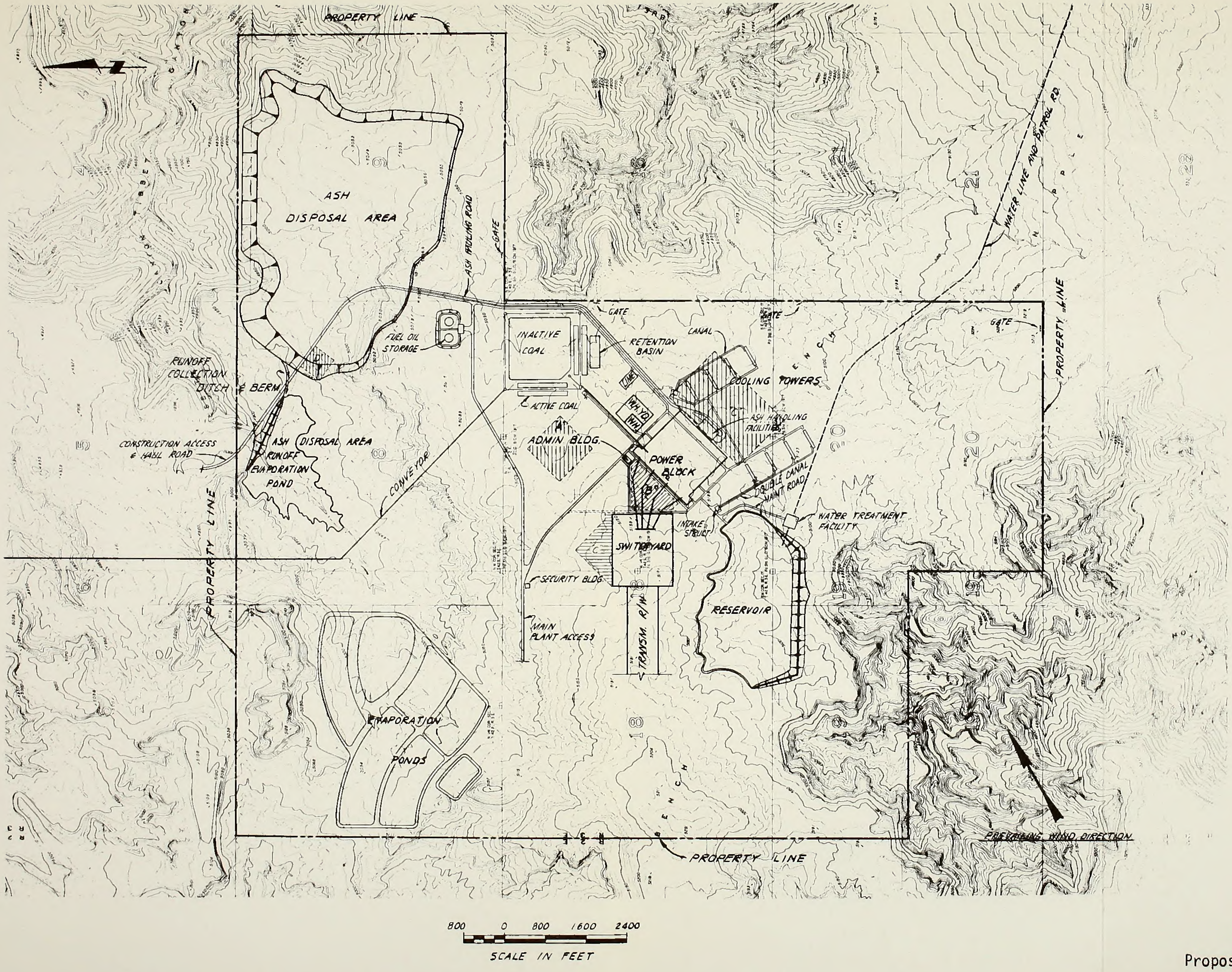
As shown in Illustration VIII-95, major site components would be located at the ridge junction in Section 17. The components would include the power block, electric power switchyard, cooling towers, in-plant ash handling facilities, coal storage areas, limestone preparation plant, administration building, shop, and warehouse. Figure VIII-16 shows the acreages involved in the Nipple Bench alternatives for the generating station and support facilities.

In addition to vehicular access to these facilities, several major systems would tie into the power block from off-site corridors. The principal transmission corridor would enter from the west. The switchyard would be placed along the east-west ridge so that line exits would be directly into this corridor.

Water and coal supply lines would enter the site from the southeast and north, respectively. The water line would terminate at a reservoir, and secondary systems would supply water to plant facilities. The coal supply conveyor would terminate at the active and inactive coal storage areas from where the plant coal system would supply coal to the units. Coal areas would be placed north of the power block near the point of coal entry.

The low drainage area north of the proposed power block would be suitable for water containment facilities. This site was selected for the proposed evaporation ponds because of the large area available. Approximately 235 acres of ponds would be required for the full 35-year life of the plant as compared to the reservoir surface area of approximately 130 acres. The lower elevation of this area would aid in delivery of waste water to the ponds. Separate evaporation ponds would be laid out to roughly conform to contours in the area to minimize the grading impact.

Terrain immediately south of the power block would provide a favorable location for the 2,640 acre-foot water reservoir. This location would be near the entry point of the water line and would be conveniently located with respect to the power block.



GENERAL NOTES

1. POTENTIAL AREAS FOR USE DURING CONSTRUCTION:

A. CONSTRUCTION CAMP
B. CONSTRUCTION FACILITIES
C. LAYDOWN
D. BATCH PLANT

ILLUSTRATION VIII-95

Proposed Plan for Nipple Bench Site

FIGURE VIII-16

Nipple Bench Power Plant Proposal

Generating Plant		Area Disturbed During Construction (acre)	Acres Permanently Occupied After Construction (acre)
1	Power Block and Switchyard	215	80
2	Coal Storage	105	85
3	Fuel Oil Storage	15	10
4	Cooling Towers	95	5
5	Evaporation Ponds	260	235
6	Buildings & Parking	(Incl. in 1)	(Incl. in 1)
7	Ash Disposal	460	460
8	Ash Disposal Reservoir	75	55
9	Ash Haul Road	10	10
10	Water Storage Reservoir	145	130
11	Retention Pond	5	5
	Total	1,387	1,077
Water pipe line			
1	Pipe line	250	80
2	Pump Station (Lake)		
3	Pump Station (Nipple Bench)		
4	Patrol Road	75	40
5	Power Line	(Incl. in 4)	(Incl. in 4)
	Total	325	120
Access Highway (70.9 Miles)			
1	Glen Canyon City to Nipple Bench and Coal Mine (24.6 Miles)	150	105
2	Nipple Bench to Cannonville, Utah (46.3 Miles)	280	195
	Total	430	300

Various sites were investigated for a disposal area for 60 million cubic yards of ash and SO_2 sludge. The proposed site would be northwest of the main site facilities on slopes leading into the northern drainage area - an isolated drainage area where erosion potential would be minimized. The site would be close to the power block, and a 60-foot wide haul road would be laid out on the most direct alignment between the ash and sludge handling facilities and the disposal area. This road would avoid the inactive coal pile and a crossing of the coal conveyor.

A storage facility would be required for fuel oil to be used during unit start-up and in main coal burner ignition. The facility would consist of two steel tanks, each with a 150,000 barrel capacity. Each tank would be surrounded by earth dikes capable of containing the total volume of oil. Fire prevention and control systems would be provided as described in Chapter I. The storage area would be downwind of and distant from all plant facilities.

In order to avoid excessive stripping of vegetation from the site for temporary facilities, construction, where possible, would take place in areas designated for facilities to be built later in the project schedule. The cooling tower area would be used for main construction lay-down. Space between the power block and switchyard would be for shops and offices during construction as this area would be graded eventually for power line clearances and to allow placement of transmission towers. Grading would be minimized and vegetation retained where practical.

In all cases, plant site development would be accomplished with the intention of preserving a maximum amount of native vegetation. There are several technical and economic reasons for preserving this vegetation, in addition to avoiding extra costs for stripping and removing such vegetation. Primarily, vegetation left undisturbed would aid in erosion protection and would reduce storm runoff, resulting in an economic savings through erosion control.

The power block and related equipment area would be graded in an interconnected multi-level system of essentially flat areas. The power block area would be graded entirely but cut with foundations resting on in-place material. Bearing capacities of these in-place materials are rated at 15 to 25 tons per square foot - capacities capable of preventing differential settlement of power block foundations. The grading plan for the power block area would result in an excess of cut material which would be used in the ash disposal area. Following site approval and prior to actual construction, additional foundation investigation would be performed. At that time a detailed study would be made regarding use of the excavated materials as foundation subbase. If the materials proved to be suitable, a balanced cut and fill approach would be used in the power block, eliminating a large portion of excess material.

Elevations in areas directly related to the power block would be established largely by the power block elevation. Support buildings would be included in the power block cut to allow ready access between them. A uniform grade would be established between power block and switchyard, allowing a balanced cut and fill approach in grading of the switchyard. To facilitate use of open circulating water canals in the cooling tower area, some excess cut material from the power block would be used to elevate this area. Differential settlement is not expected to be a significant problem here since foundation loadings are lighter. The coal storage area would also be raised to reduce the angle of the plant coal supply conveyor.

The grading design would result in an approximate material excess of 3.5 million cubic yards, including the evaporation ponds. This material would be mainly sandstone rock fragments up to 2 feet in size and other material unsuitable for structural fill. The material would be removed to the ash disposal area and placed as a spoils pile in a portion of the area. During plant operation, this material would be incorporated into the ash and sludge fill.

Where possible, plant facilities would be built to avoid major drainage channels. One major exception would be the channel at the north side of the plant near the ash and sludge disposal area. To minimize total grading impact, the proposed runoff collection pond for this area would be located in the drainage channel. Runoff would be collected and carried by culvert around the pond and released into the natural channel on the downstream side. As an alternative, the size of the evaporation pond could be increased to retain all runoff from the upstream area.

All runoff from material storage and construction activity areas would be retained in a retention basin. Other plant areas would be drained to natural drainage channels. This plan conforms to effluent guidelines and standards established by the Environmental Protection Agency (EPA). The retention basin would be equipped with an oil-water separator which would remove industrial wastes and allow release of the water to a natural watercourse. The EPA standards state that total suspended solids shall not exceed 50 milligrams per liter and that the pH shall be within the range of 6.0 and 9.0. If these standards cannot be met, contents of the retention basin would be pumped to the liquid waste evaporation ponds.

The size of the retention basin would be based on a 24-hour, 10-year recurrence interval rainfall amount (2 inches in 24 hours). It would cover 1 acre to a depth of 15 feet, including a 3-foot freeboard and a maximum water level of 12 feet. A mudstone lining 1 foot thick would prevent degradation of ground water.

Since this basin would function only as a holding basin, it would normally be maintained at water depths of less than 2 feet, except during or immediately following a rainfall. It would fill to maximum depth only during a 10-year recurrence rainfall (2 inches in 24 hours).

A spillway would be provided in the retention basin to prevent overflow of the containment dike in the event of rainfall exceeding the design amount. This flow would be released into a natural drainage channel. In the unlikely event that such spillway flow should occur, the mixing of this relatively small flow with major amounts of uncomtaminated runoff from other sources would result in sufficient dilution to minimize the effect.

Power block - boilers and turbines

The generating plant at the alternate location on Nipple Bench would be similar to the plant at the Fourmile Bench site as described in Chapter I.

The Nipple Bench location would influence size and horsepower of equipment which is dependent upon outside air density and atmospheric pressure. Equipment, such as boilers, fans, air compressors and various controls, would be designed to operate at the higher atmospheric pressure and air density of Nipple Bench. Nipple Bench is 5,100 feet above sea level as compared with the Fourmile Bench elevation of 6,100 feet above sea level.

Some components, such as stacks, would be influenced by changes in terrain and surrounding environment. The proposed plant would have four stacks. Due to differences in terrain and meteorological conditions of the two sites, the Nipple Bench site would require higher stacks to achieve the same stack emission dispersion as that of stacks at the Fourmile Bench site. The stacks would be approximately 800 feet in height (600 feet for Fourmile Bench) with a bottom outside diameter of approximately 60 feet and top outside diameter of approximately 30 feet. Because of the more dense air at Nipple Bench, boilers and air and gas handling equipment would be approximately 5 percent smaller than at Fourmile Bench.

Evaporation ponds

Evaporation ponds would be built in Section 7, the northwest corner of this plant site, rather than in the southern corner as at Fourmile Bench. This location at Nipple Bench would eliminate the necessity for major flood control provisions.

To prevent pollution of ground water, ponds would be lined with a maximum 2-foot layer of clay. The material would be obtained from deposits of tropic shale either along the proposed Nipple Creek main access corridor from Glen Canyon City to the Nipple Bench site, or from a site 4 miles north of Nipple Bench along side the proposed access road. The clay has a permeability coefficient of 0.05 feet per year, and a 2-foot layer would provide an adequate lining for the life of the plant. A 6-inch layer of on-site material would be placed over the clay to protect it from damage from waves or weathering and from wetting and drying action.

Water management records would be kept for the evaporation ponds, and leakage caused by a possible break in the lining would be detected through the ground water monitoring system. Although this is not likely with a clay lining, the leak would be repaired when it occurred.

The ponds would handle service waste and effluent from the sewage treatment plant. All ponds would be designed using the same criteria as for the Fourmile Bench site to assure that no degradation of ground water or Lake Powell water would occur.

Access roads

Nipple Bench and the proposed coal mine can be reached by four-wheel drive trails during fair weather. These trails would have to be leveled and widened to allow access for construction crews and equipment to the plant site and coal mine. There would be no need for a road from the north (Cannonville

area) to these areas. The access road alternates to Nipple Bench are from the south only (Glen Canyon City area). Segments of the access road alternates for the Nipple Bench site are shown in Illustration VIII-96.

The Glen Canyon City to Nipple Bench (via Nipple Creek) road segment (B-1) would be approximately 14.2 miles, with no grades steeper than 4 percent. Three stream crossings would be included within this segment. An exposed layer of shale can be found over a short section of Nipple Creek. This shale has very poor characteristics for road building and would have to be kept moisture-free and possibly excavated to a depth such that its swelling characteristics could be negated. Aggregate for road construction would be brought from Wahweap Creek.

The coal mine to Nipple Bench (via Tibbet Canyon) 10.4 mile road segment (B-3) would extend with no grades steeper than 4 percent. There would be seven stream crossings. The full route from the coal mine down Missing Canyon, up Warm Creek and up Tibbet Canyon would follow narrow, winding canyons. Some aggregate can be found in Warm Creek, but additional amounts would have to be hauled from Wahweap Creek.

Water storage

Water from Lake Powell would be pumped to the reservoir which would provide continued service to the plant in the event of an outage of the water make-up system. The reservoir capacity would be based on the reliability of the make-up water pipe line and on an economic study of reservoir size versus increased pipe line size. The reservoir would occupy approximately 130 acres of land with a 65 acre surface area and a 40-foot average depth. It would contain approximately 2,640 acre-feet (860,000,000 gallons) of water, sufficient to supply the station for 14 days at maximum capacity during the hottest summer month.

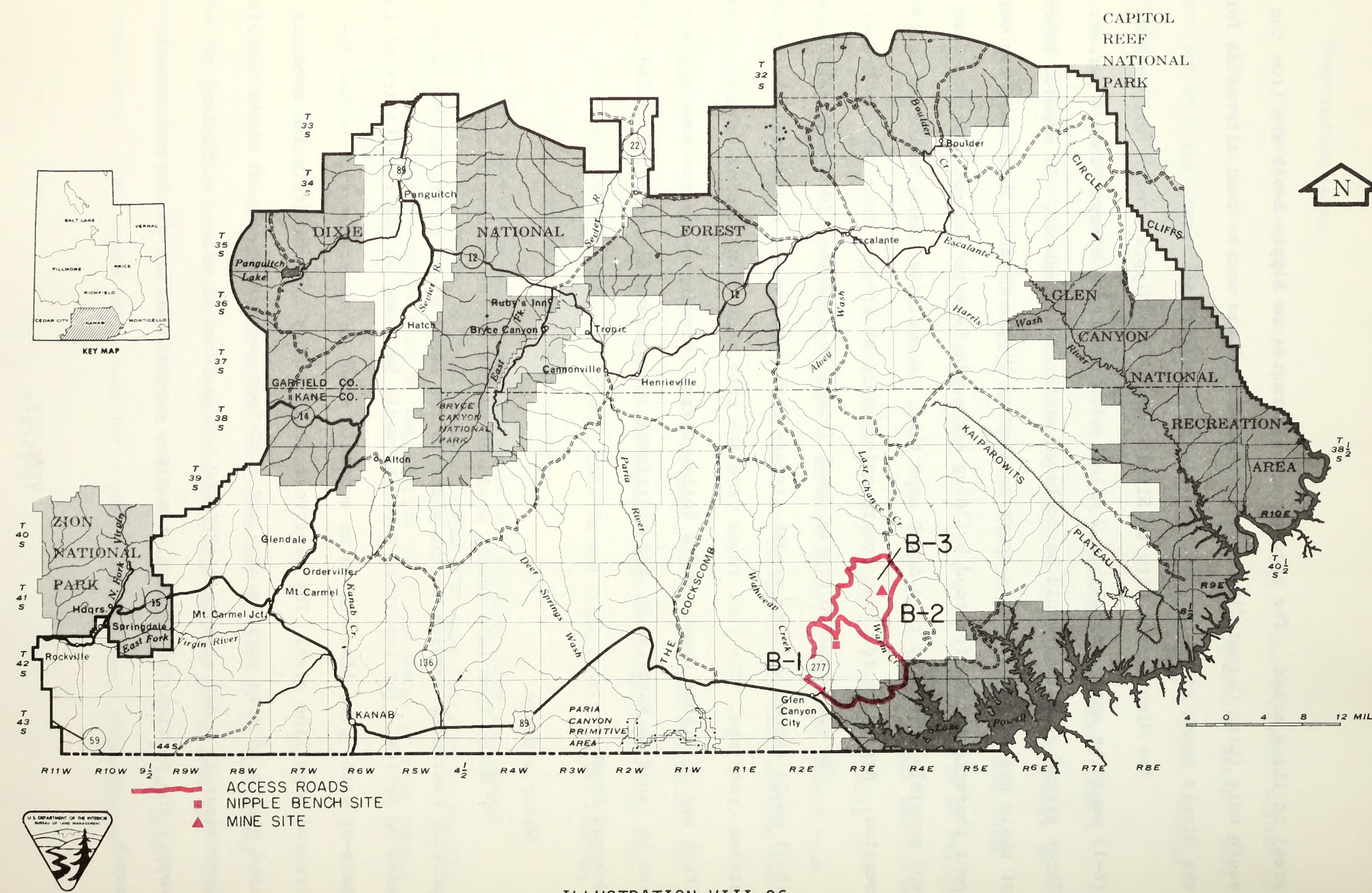


ILLUSTRATION VIII-96

Nipple Bench Access Road Alternatives

The reservoir would be located in the southwestern portion of the site immediately upstream of Thompson Canyon. This location would take advantage of a natural bowl-shaped area to minimize earthwork required for the reservoir. The location would also be desirable because it has a very small tributary drainage area upstream of the reservoir, greatly reducing the chance of a significant increase of flow to the reservoir from storm runoff. The reservoir would also be located so that a safe drainage path were provided for flood waters in the event some mishap should cause breakage in the dam.

The dam design would be developed using a dynamic stability analysis. Predominately on-site materials would be used to construct the dam which would have an upstream slope of four horizontal to one vertical and a downstream slope of three horizontal to one vertical. The crest width of the dam would be 30 feet with a maximum 24-foot-wide asphaltic concrete paved road encompassing the reservoir. The reservoir would have an inlet structure, a 3-foot diameter concrete encased pipe line through the dam fill, and a pump structure at the downstream toe of the dam for pumping reservoir water to the power block.

The minimum freeboard (the difference in elevation between the crest of the dam and maximum reservoir water surface) would be 5 feet. The normal freeboard (the difference in elevation between the crest of the dam and normal reservoir water level) would be 6 feet. The reservoir would be designed to contain the water resulting from a 100-year storm without releasing flows through the spillway. The spillway would be designed for flows well in excess of a 100-year storm and would conform to the minimum spillway capacity required for dam construction in Utah.

The reservoir would be lined with a minimum of 6 inches of clay material. This would reduce seepage rate of the reservoir to approximately 300 acre-feet (186 gallons per minute) of fresh water per year. Upstream slopes of the dam and

interior slopes of the reservoir would be protected against destructive wave action by emplacement of large stones from the crest of the dam to several feet below minimum water level. Downstream slopes of the dam would be protected against erosion by wind and rainfall runoff by a layer of rock approximately 1 foot thick.

Solid waste disposal

The selected disposal site would be located on a bench-top land fill in the northeast corner of the area, in Sections 8 and 9. The area is on a gradual slope on the south side of Nesbitt Canyon immediately upstream of the canyon rim. This location necessitates some rerouting and retention of upstream runoff. However, erosion of the ash fill would be minimized by locating the upper perimeter along the crest of the ridge. Details for placement of ash and sludge in this area would be as previously described for Fourmile Bench.

At Nipple Bench, the collection pond would be designed to retain (for evaporation) the maximum annual 23-inch rainfall from a 100-year storm occurring at the ash disposal area and adjacent minor tributary runoff areas. This pond would occupy approximately 57 acres.

An earth dam approximately 30-feet high would be built for the pond to retain 430 acre-feet (140 million gallons) of storm runoff. Material for the dam would come from the interior of the landfill site and require 180,000 cubic yards of excavation. The dam would probably consist of dense sandstones for ballast with an impervious core made from clays in the plant area.

Coal mine

Construction of the power plant on Nipple Bench would have no significant impact upon the proposed coal mine other than to possibly cause relocating

of virtually all coal mine related facilities to efficiently direct movement of coal to the south, toward Nipple Bench, instead of to the northwest, toward Fourmile Bench.

Coal leases held by the participants are independent of land used as a power plant site. Therefore, regardless of where the power plant may be located, coal reserves scheduled to be mined would remain the same.

Construction and operation schedules and plans for coal mines with a Nipple Bench power plant site would be essentially identical to schedules and plans for a Fourmile Bench site. Both schedules call for a four-year construction project. Overall construction effort for the two sites would be almost identical, and savings in construction effort realized in one aspect would likely be expended in another.

Coal transportation alternatives

Because of the difference in elevation between the Fourmile Bench power plant site and the coal mines, conveyor belt transportation of coal is the only economically feasible technique of coal delivery. However, if the power plant site were located on Nipple Bench, no significant difference in elevation would exist and coal transportation could be by conveyor belt, railroad, or by slurry pipe line depending upon an overall economic analysis of the project. The participants have proposed railroad transportation as a possible alternative to conveyor belt transportation if the power plant were located on Nipple Bench.

A decision between the three proposed alternatives is difficult prior to conducting an overall economic analysis. Such an analysis is impossible at this time due to conceptual design of project proposals. Respective environmental impacts of the alternatives would remain essentially the same as discussed for the Fourmile Bench proposal earlier in this chapter.

UP&L power line alternatives to coal mine - Nipple Bench

Proposed route

The UP&L 138 kV power line would be constructed from an existing 230/138 kV substation adjacent to Utah Power & Light 230 kV line near the Paria River crossing. The line would proceed east paralleling the proposed Kaiparowits west 500 kV line corridor to the west boundary of the Nipple Bench plant site area. The line would then proceed north following the new highway to the coal mine area near Wesses Cove. This route would be 25.5 miles long with a 1 mile temporary tap leading to the Nipple Bench plant site (Illustration VIII-97). The temporary tap would be used to supply construction power and possible startup power for the Nipple Bench plant. This route would require 53 acres of surface disturbance with associated vegetation disturbance and increased runoff and sediment production. After construction, runoff from a 50 year storm would increase by 0.90 of an acre-foot/year above the present runoff rate. Sediment load would be expected to increase by 0.02 acre-feet/year above present sediment yield. Mitigating measures in the form of reseeding and water control structure would reduce the runoff and sediment yield by 0.36 acre-feet/year and 0.01 acre-feet/year respectively. Reseeding success for this area would be less than 3 years out of 10. Approximately 6 miles of this route would parallel the proposed new highway and could be a visual intrusion to users of the highway. Approximately 5,060 vehicles per day would travel this route. A temporary tap approximately one mile long would be made from the permanent 138 kV line at the west boundary of the Nipple Bench plant site to supply construction power and possible startup power for the Nipple Bench plant.

Alternate No. 1

UP&L would construct a 230/138 kV substation near Glen Canyon City. The substation would be constructed about 1/4 to 1/2 mile south of where the UP&L

ILLUSTRATION VIII-97

Proposed Nipple Bench UP&L Power Line

230 kV line crosses U.S. 89 near Glen Canyon City. The line would follow the proposed Nipple Bench south 500 kV corridor to the west boundary of the Nipple Bench plant site, then would proceed north 2.5 miles where it would generally parallel the new highway to the coal mining facility (see Illustration VIII-98). A temporary tap approximately one mile long would be made from the permanent 138 kV line at the west boundary of the Nipple Bench plant site to supply construction power and possible start-up power to the Nipple Bench plant.

This alternative would be 16.5 miles long and would require 21 acres less surface disturbance than the proposed Nipple Bench route. Runoff and sediment yield after construction would be 0.98 acre-feet/year and 0.04 acre-feet/year less than the proposed route. Mitigation would further reduce these rates by 0.12 acre-feet/year and 0.005 acre-feet/year, respectively. This alternative would place the power line through the middle of the proposed new town on East Clark Bench. This would be a visual intrusion and could possibly conflict with construction of the new town. Undergrounding of the power line through the new town could eliminate these impacts. Six miles of this route would also parallel the new highway. Figure VIII-17 shows land use for these routes.

Power line communication sites for proposed route

Barney Top site

The Barney Top site is an existing microwave active repeater with an access road, a small building and two 10-foot dish type antennas, mounted on top of a 200-foot tower. The building and tower, located in T. 35 S., R. 1 E., Sec. 15, are surrounded by a chain link fence. The proposed additions would include a 10-foot dish type antenna mounted on the same 200-foot tower and associated radio equipment in the existing building. There would be no disturbance to the surrounding vegetation.

FIGURE VIII-17

Land Use for UP&L Power Line - Nipple Bench

LENGTH OF POWER LINE

	Permanent Line	Temporary Line to Nipple Bench
Proposed route	25.5 miles	1 mile
Alternate No. 1	16.5 miles	1 mile

RIGHT-OF-WAY REQUIRED

	Permanent Line	Temporary Line to Nipple Bench
Proposed route	207.3 acres	9.7 acres
Alternate No. 1	160.0 acres	9.7 acres

LAND OCCUPIED AND DISTURBED

	Permanently Disturbed[a]	Temporarily Disturbed[a]
Proposed route	12 acres	41 acres
Alternate No. 1	7 acres	23 acres

ACCESS ROADS REQUIRED

	Main Access	Spur Roads
Proposed route	19 miles	2 miles
Alternate No. 1	10 miles	2 miles

[a] By both permanent and temporary lines.

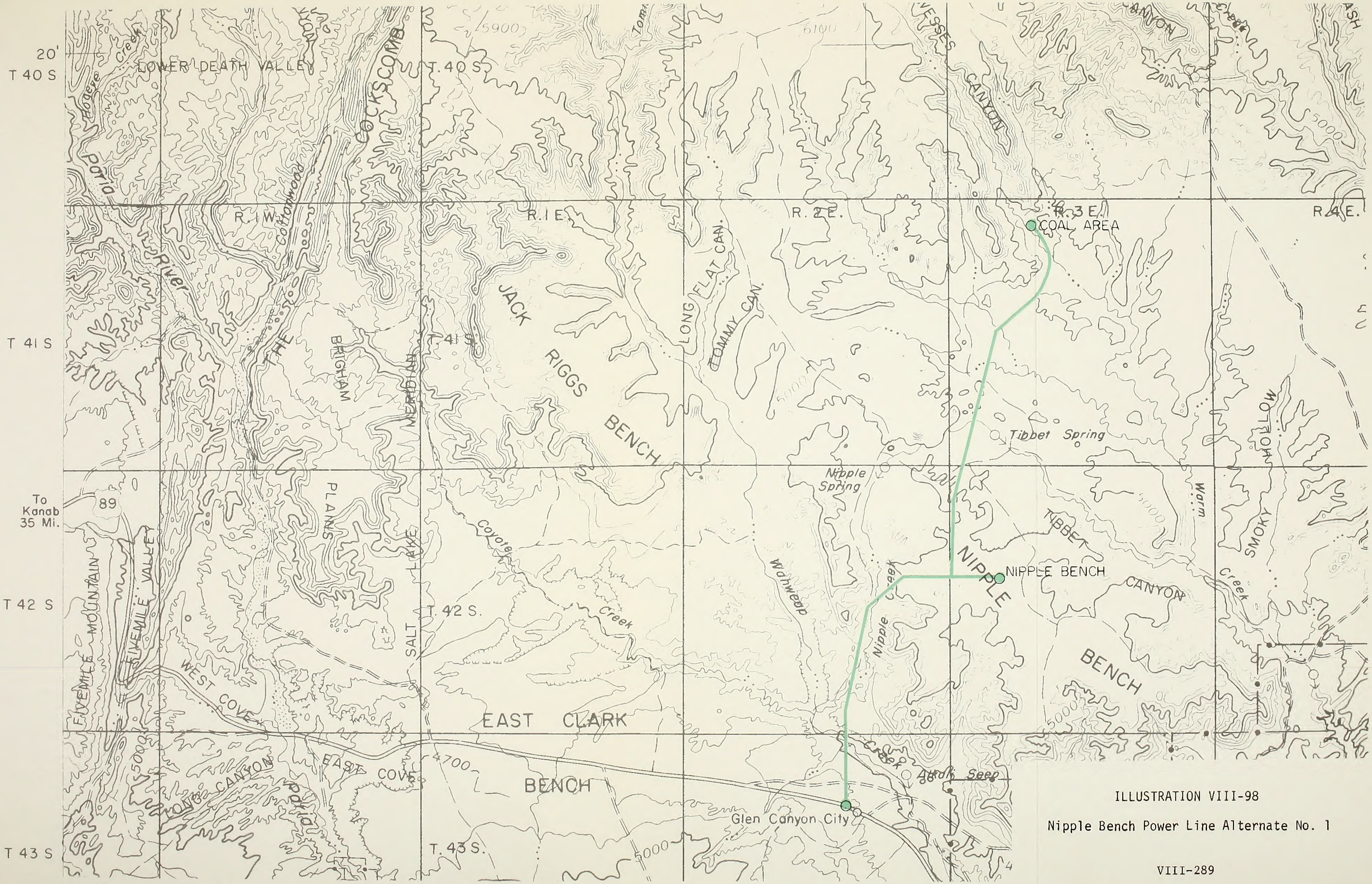


ILLUSTRATION VIII-98

Nipple Bench Power Line Alternate No. 1

Cedar Mountain site

Cedar Mountain is currently a television translator site with an access road running to the site. A 500 kV powerline and a 69 kV powerline extend over the top of the mountain near the radio site. The microwave active repeater would include a small building, a power line for electrical service, 20-foot tower with 10-foot dish type antenna, and a chain link fence around the tower and building and would occupy an additional area of approximately 1/2 acre. The station is located approximately 5.3 miles south of Glen Canyon City and would not be visible from U.S. Highway 89.

Power line communication sites for alternate No. 1

Barney Top site

This site would be the same as for the proposed route.

Cedar Mountain site

Cedar Mountain is currently a television translator site with an access road running to the site as described above. The microwave passive repeater would be located on a plot 40' x 40' square. Site grading and disturbance to vegetation would not be necessary. The passive repeater would not require electrical service. A chain link fence would enclose the passive repeater. It would be located on the top of the mountain, but not visible from the U.S. Highway 89.

Land use for substations

Transmission Substation (230/138 kV) area would be approximately 2.0 acres plus access road into substation site as noted below:

Paria River - Existing

Glen Canyon City Site - Approximately 3,000 feet (25 feet wide) of access road (1.55 acres).

Distribution Substation (138/13.8 kV) area would be approximately 1.0 acre. No access road requirements since site would be located in the plant construction area.

Transmission system

Introduction

If the Kaiparowits Plant were built at Nipple Bench instead of Fourmile Bench, there would be four proposed transmission system routes. One would consist of a single 500 kV line to Eldorado Substation. The second route would consist of three parallel 500 kV lines to the east sides of the Colorado River. Then one would go to Navajo Generating Station, a second would go to Westwing Substation, and third would go to Mohave Generating Station. An alternative would be to use the Ty Hatch route to Eldorado Substation and another would be the Wahweap alternate. See Illustration VIII-99.

Nipple Bench to Eldorado proposed route

This route would commence at an arbitrary point at the northwest corner of the Nipple Bench site and proceed due west seven and one-half miles to join the East Clark Bench alternate route for the Kaiparowits to Eldorado proposed route. In the first mile, the route would cross edges of some tributary washes which lead into Nipple Creek. Some deviation from the route shown may be required to adjust lines to terrain. After three miles, there would be a 500-foot drop in

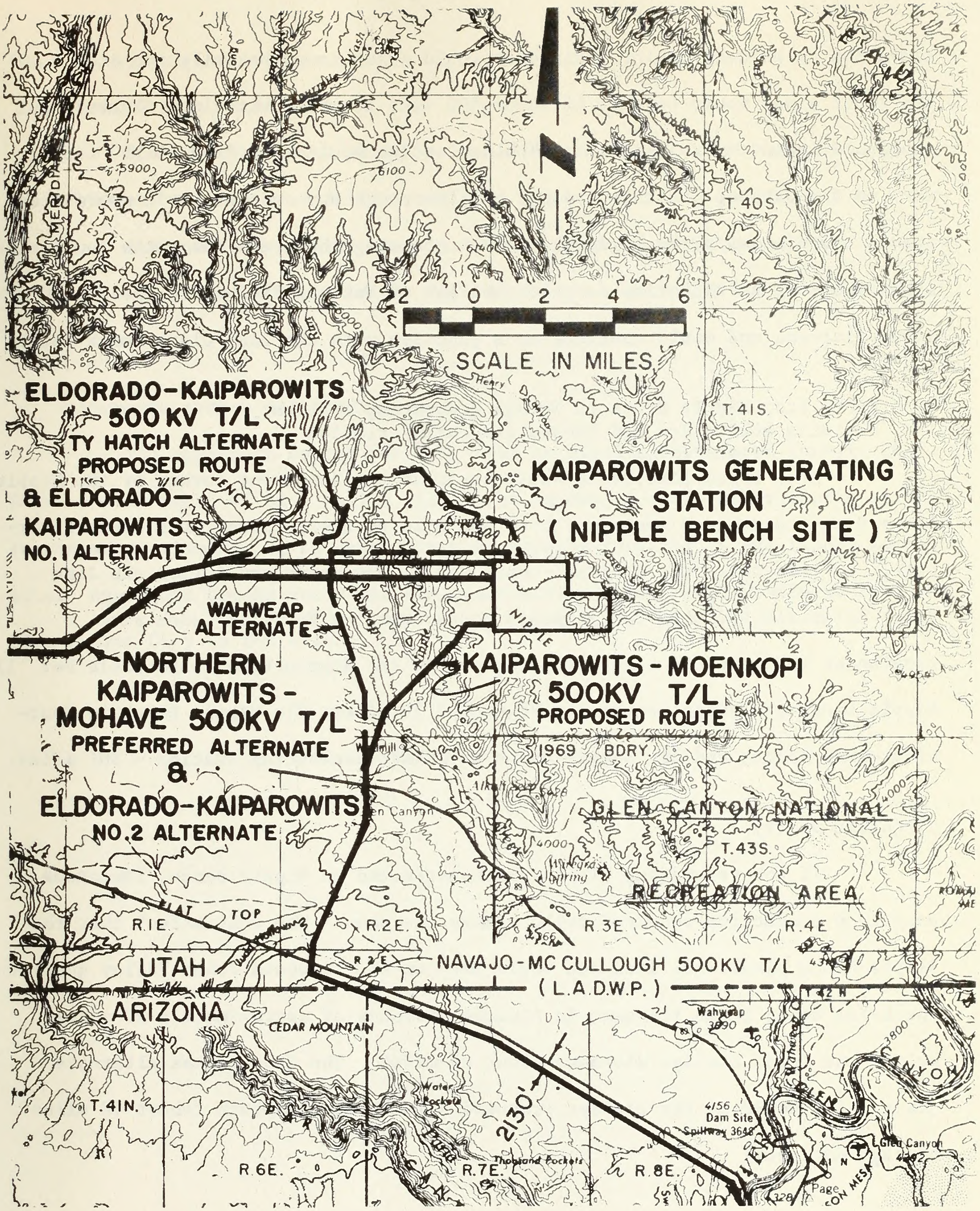


ILLUSTRATION VIII-99

Nipple Bench Alternate Plant Site
Transmission Line Routes

elevation to Wahweap Basin. This drop would occur in essentially two stages. The first stage would consist of about 400 feet to where the slope flattens out enough for good tower locations. The next stage would be a drop of 100 feet or more to the Wahweap drainage system. As the route proceeds west, it would cross uneven terrain near Wahweap Creek. After crossing the Creek the route would rise about 250 feet in elevation as it climbs out of Wahweap Basin onto the East Clark Bench Plateau, and would continue to a junction with the East Clark Bench route.

Route from Nipple Bench to Navajo generating station, Westwing substation and Mohave generating station

This three line route would begin at the southwest corner of the Nipple Bench Site and proceed west for about one mile to the proposed John Henry alternate. At this point the proposed route would turn south and follow the John Henry alternate and then the proposed route from the Fourmile Bench site. Lengths of the proposed alternate routes from the Nipple Bench site would be: 1) Nipple Bench to Navajo Generating Station - 33 miles; 2) Nipple Bench to Westwing - 290 miles; and 3) Nipple Bench to Mohave Generating Station - 301 miles.

Limestone quarry

If the generating plant were constructed on Nipple Bench, limestone usage and production required would remain the same. The only effect that the Nipple Bench plant site location would have on the proposed Johns Valley quarrying operation would be an increase in haulage distance of approximately 20 miles, making the total haulage distance about 80 miles. The Canaan Peak alternate quarry site would be the closest proposed site to Nipple Bench (about 40 miles haulage distance).

Implementation alternatives

Construction water

Construction water pipe line would be adjacent to the patrol road in the permanent water line corridor to Nipple Bench.

Alternate sources of construction water would be wells in Wahweap Basin north of Glen Canyon City, with the alternate pipe line following the proposed access road.

Aggregate source and transport

The aggregate source would be from an existing developed deposit in Wahweap wash north of Glen Canyon City. The aggregate would be processed at the source area, eliminating the need for a processing facility at the Nipple Bench site. Aggregate trucks would use the construction access road developed from Glen Canyon City to the site.

Description of existing environment

Generating plant facilities

Nipple Bench is 14 miles south-southwest of Fourmile Bench and 21 miles northwest of the Navajo power plant. The proposed site elevation (5,200 feet above mean sea level) is 1,000 feet lower than Fourmile Bench. The proposed site on Nipple Bench is situated on a relatively flat, irregularly shaped 3 by 5 mile plateau. Elevated terrain, 6 to 12 miles north, rises approximately 1,000 feet above the site. About 27 miles northeast and east, Fiftymile Mountain rises approximately 2,000 feet above the site. Eighteen miles to the west, Cockscomb Ridge is approximately 6,000 feet high, and 30 miles northwest the Canaan Mountains rise to over 9,000 feet in elevation. Approximately 6 miles to the south, the terrain drops 1,000 feet.

Climate

Small differences in relative humidity, precipitation, and evapotranspiration exist between Fourmile Bench and Nipple Bench because of the 1,000-foot difference in elevation. On-site meteorological measurements at Nipple Bench began November 1, 1971 and at Fourmile Bench May 9, 1974 (Dames and Moore, 1975). Short-term data indicate that the mean annual temperature at Nipple Bench is 3° F higher. Temperature data for the first winter at Fourmile Bench show much lower temperatures than Nipple Bench, both for extreme minimums and monthly means (Dames and Moore, 1975). As an example, 0° F temperatures are rare at Nipple Bench, but during the first winter operation at Fourmile Bench a December low of -15° F was recorded. The temperature differential between the two sites becomes less during the warm season.

Annual average rainfall at Nipple Bench would be expected to average 7 to 8 inches, slightly lower than Fourmile Bench. Three years of measurements at Nipple Bench have averaged 4.23 inches per year. Potential evapotranspiration is greater at Nipple Bench, averaging 30 to 33 inches. The 160 frost-free days, representing the growing season, is slightly longer than at Fourmile Bench. Differences in surface winds between the two sites appear to be minor. Prevailing winds are westerly at Nipple Bench with an average speed of 11.3 mi/h and west-southwesterly at Fourmile Bench with a slightly lower velocity. The annual velocity at Nipple Bench is slightly higher than at Fourmile Bench.

Upper winds which would influence the plume have a similar flow pattern for both Nipple Bench and Fourmile Bench. They are predominantly from the southwest and west toward the northeast and east with an average wind speed of 11 mi/h (Dames and Moore, 1973; Spangler et al., 1973; Spangler et al., 1974).

Atmospheric stability structure measurements of the lowest 3,000 feet above Nipple Bench in January, February, October and December 1971 (Dames and Moore, 1973) indicated neutral conditions 40 percent of the time and stable conditions 60 percent of the time with a small probability of unstable air within that depth. Meteorological and plume tracer studies at Nipple Bench in November 1973 (Spangler et al., 1974) indicated a predominance of moderately stable to very stable conditions from the surface to 1,100 feet and neutral to slightly stable conditions within the calculated plume elevation during morning (7:30 a.m.) measurements. Afternoon measurements indicated a predominance of neutral conditions from surface to 1,100 feet and neutral stability conditions within the expected plume elevation. Very stable atmospheric conditions are expected to occur infrequently at both sites. Observations suggest that turbulence, which would enhance plume dispersion, was consistently lighter at Nipple Bench than at

Fourmile Bench (Spangler et al., 1974). Data collected indicate a greater frequency of morning surface-based inversions at Nipple Bench compared with Fourmile Bench.

North American weather consultants (NAWC) conducted a temperature sounding program at Nipple Bench and Fourmile Bench from February 4, 1974 to January 27, 1975. A total of 494 soundings were taken (NAWC, 1975). Inversion characteristics and vertical atmospheric stability analysis were obtained from these measurements. The study indicated that although there were minor seasonal variations, the differences between the two sites were minimal.

Stagnation conditions, which include a prolonged limited mixing condition and low wind speeds, are expected to occur with a slightly greater frequency at Nipple Bench than at Fourmile Bench. Frequency of occurrence of such conditions is expected to be seven to eight times per 5 years at Nipple Bench and four to five times per 5 years at Fourmile Bench. Expected duration at both locations would be 5 to 7 days.

Air quality

Air quality is generally excellent. A complete description of air quality in the Kaiparowits Plateau impact area is presented in Chapter II. Nipple Bench is within the plateau impact area.

Geology and topography

The Nipple Bench area is flat and gently slopes to the southeast. Average elevation is 5,100 feet above mean sea level. Geology of the area is primarily the Straight Cliffs formation, underlain by Tropic shale and Dakota sandstone formations. There are no known coal beds or other minerals underlying Nipple Bench.

Soils

Soils on Nipple Bench belong to the Badland-Rockland soil association. These soils are moderately-coarse textured varying from shallow to moderately deep (24 to 30 inches). Erosion susceptibility is moderate with an estimated average annual sediment yield of 0.45 acre-feet per square mile. These soils have an infiltration rate of 2.0 to 3.5 inches per hour. Soils found on Nipple Bench could only be successfully seeded 3 to 5 years out of 10 because of low annual rainfall.

Water resources

Nipple Bench is drained by intermittent and ephemeral streams that have carved deep, steep-walled canyons leading from the bench top. Part of the drainage is to Warm Creek and part is to Wahweap Creek. Although these streams seldom have continuous flow, they are subject to periodic intense cloudburst flooding, as discussed in the water resources section of Chapter II.

The only perennial sources of water on Nipple Bench are Nipple and Tibbet Springs. These springs discharge from perched aquifers, as the depth to the regional water table in this area exceeds 1,000 feet. Other perched aquifers exist beneath Nipple Bench and discharge as saline seeps in the lower reaches of Tibbet Canyon. These aquifers apparently are incapable of yielding large sustained quantities from water wells.

Both Nipple and Tibbet Springs have maximum discharges of less than 10 gallons per minute. When they were sampled on May 30, 1974, the total dissolved solids concentration of Nipple Spring was 578 mg/ℓ and that of Tibbet Spring was 1,140 mg/ℓ. Chemical analyses of water from these springs are given in Chapter II, Figure II-29.

The best potential source of ground water for large-scale development at Nipple Bench is the Navajo Sandstone. Aquifers in the Navajo Sandstone are

capable of yielding several hundred to more than 1,000 gpm of fresh water to wells. However, this formation lies at depths of 2,000 to 4,000 feet beneath the surface of Nipple Bench.

Vegetation

Two major vegetation types occur on Nipple Bench, blackbrush and a mixed shrub-grass association. The shallower soils, 27 cm or less, support nearly pure stands of blackbrush. The mixed shrub-grass association is more extensive, occupying the deeper soils with a maximum known depth of 91 cm.

The major components of these vegetation types are blackbrush (*Coleogyne ramosissima*), spiny hopsage (*Grayia spinosa*), Mormon tea (*Ephedra viridis*), rabbit-brush (*Chrysothamnus vicidiflorus*), matchweed (*Gutierrezia sarothrae*), fourwing saltbrush (*Atriplex canescens*), blue grama grass (*Bouteloua gracilis*) and galleta grass (*Hilaria jamesii*).

No unique communities occur on Nipple Bench. However, one known population of *Peteria thompsonae* occurs north of the plant site. This plant species is classified as threatened, and has a disjunct distribution in southern Utah and northern Arizona.

Wildlife

Wildlife on Nipple Bench consists primarily of small mammals, songbirds, birds of prey, reptiles and invertebrates. Species diversity is lower than on Fourmile Bench and large mammals are seldom seen other than coyotes. Woodland species of small wildlife such as chipmunks, packrats and pinyon jays that are found on Fourmile Bench are absent or scarce on Nipple Bench.

Ecological interrelationships

Although there are two perennial sources of water at the edge of Nipple Bench, the vegetation available supports few big game animals. Vegetation is

sparse because of low precipitation, high evapotranspiration, and low water holding capacity of soils. Extensive use of the bench by most large mammals is further inhibited by lack of cover and by isolation from other types of habitat. The open desert grass-shrub vegetation is best suited for reptiles, small mammals, birds and a few predators that prey on them. Coyotes are commonly seen - apparently attracted by black-tailed jackrabbits and other small mammals. The short, sparse vegetation and level terrain also provide a good hunting area for large raptors.

On the Nipple Spring side of Nipple Bench all runoff flows into Wahweap Drainage. The remainder of Nipple Bench drains into Warm Creek Drainage. The riparian habitats at Nipple Spring, Tibbet Spring and other moist sites in the drainages of Nipple and Tibbet canyons are the only sources of water for wildlife.

Paleontology, archaeology and history

Nipple Bench exhibits fewer fossils than does Fourmile Bench. Thirty-five archaeological sites exhibiting complex associations of features and artifacts have been recorded within the proposed alternative plant site (15) and half-mile buffer zone (20). There are no known sites of historical value on Nipple Bench (Fish, 1974).

Recreation

The only recreational activities on Nipple Bench are hunting and sightseeing of a very limited nature.

Land uses

Livestock

Nipple Bench is used for livestock grazing. One livestock operator has a grazing allotment of 948 animal unit months (AUMs).

Mineral

There are no minable coal deposits underlying Nipple Bench, nor is there any other mineral activity taking place.

Wood products

There are no commercial wood products on Nipple Bench.

Agriculture

There are no agricultural lands on Nipple Bench.

Transportation facilities

Nipple Bench has sparsely scattered truck and stock trails traversing the area. However, there are no improved access roads to or on Nipple Bench.

Transmission facilities

Nipple Bench to Eldorado proposed route

Few, if any, significant differences would exist with regard to natural or human resources as discussed for the proposed Fourmile Bench site. Nipple Bench is in a zone of slightly lower rainfall than Fourmile Bench, but data are lacking from which to determine differences in impacts on air quality or revegetation potential for transmission lines from the two sites.

The first 5 miles of this route would follow the same alignment as the first 5 miles of the proposed Wahweap alternate of the Kaiparowits-Moenkopi route beginning at the Nipple Bench site.

Proposed route from Nipple Bench to Navajo generating station, Westwing station and Mohave generating station

The description of the environment for the Nipple Bench to Eldorado proposed route mentioned above also applies to the first mile of this alternate route. Description of the environment for the John Henry alternate applies to the remainder of this proposed route.

Ty Hatch alternate

The Ty Hatch alternate crosses the same type of terrain as the proposed Fourmile Bench site transmission line, and the environment would be essentially the same.

Wahweap alternate

Descriptions of the environment for the first 5 miles of the proposed Nipple Bench to Eldorado route and the proposed routes from Fourmile Bench apply to the Wahweap alternate.

Environmental impacts

Impacts within the Kaiparowits Plateau impact area resulting from development and increased population would occur if the generating station were to be built at either the Nipple Bench site or the Fourmile Bench site. These impacts, common to both sites, are discussed in Chapter III.

Generating plant facilities

Air quality

Studies were conducted to evaluate the impact on air quality if the plant were located at the Nipple Bench site. These studies included the meteorology and diffusion climatology studies (Dames and Moore, 1973), oil smoke tracer release study (Spangler et al., 1973), dispersion climatology, oil smoke and fluorescent particle tracer studies (Spangler et al., 1974), visibility study (Bechtel, 1974), plume opacity study (Radian, 1974), cooling tower drift and fogging study (Bechtel 1974), salt deposition study (Meteorology Research, Inc., 1974), and inversion characteristics and vertical stability analysis (Golden and Spangler, 1975).

The Dames and Moore study (1973) stated the following:

a. No adverse meteorological condition (destructive winds, extreme temperatures, or damaging precipitation) is probable at the Nipple Bench site.

b. The site is free of surrounding terrain obstacles that could cause channeling of wind or aerodynamic effects on the stack effluents of the generating station.

c. The site is well ventilated with an average wind speed at stack height of at least 5 meters per second (11 miles per hour).

d. Stable conditions are common in the region (approximately 60 percent of the time) which will usually serve to prevent the plants effluent from reaching the ground in significant concentrations.

The North American Weather Consultant oil-fog simulation study of Fourmile Bench, Nipple Bench, Horse Flat, Dry Bench and John Henry Bench (Spangler et al., 1973) stated:

> "Although the thermal structure of the atmosphere did not change significantly between sites, visual observation of the smoke released over each site under various meteorological conditions often demonstrated significant variations in plume dispersion characteristics and terrain effects. The observations clearly show that Fourmile Bench and Horse Flat have minimum potential for elevated terrain effects upon plume dispersion. Even at Nipple Bench, the smoke was observed to descend sharply when leaving the plateau and later fumigate around the elevated terrain to the northwest."

The study further stated, "In summary, the visual and quantitative measurements of the smoke tracer plumes strongly suggest that the most favorable plume transport and dispersion characteristics are found on Fourmile Bench and Horse Flat."

The North American Weather Consultant study in 1973 (Spangler et al., 1974) indicated the following:

> "In general, neither site (Nipple and Fourmile Bench) has revealed any situation that would lead to a significant impact of SO_2 upon surrounding terrain. The plume transport and diffusion, however, would be different for these sites and the influence of the surrounding terrain would be another factor to consider. Examining the potential impact in more detail, it was found in both November 1973 and May 1974 field data that whenever Fourmile Bench stable plumes were transported towards the northeast, they cleared the elevated terrain. The plumes were observed to follow the terrain rather than fumigate or impact upon it. The terrain in the immediate vicinity of the site is well below plume altitude and quite rugged, leading to enhanced dispersion. However, the plume dispersion patterns observed at Nipple Bench included transport towards the elevated terrain within 6-10 km (4-6 miles) to the northwest. When oil fog plumes were released in the vicinity of these cliffs during the November 1973 program (Spangler et al., 1973) the plumes were drawn toward the cliffs and several fumigated onto the terrain. A release over Nipple Bench in November 1973 traveled northwest toward the cliffs and mixed to near the terrain in the vicinity of Jack Riggs Bench. This type of dispersion condition requires southeasterly flow and stable air mass which, climatologically, is a very infrequent condition at Nipple Bench. In summary, the field programs conducted for the Kaiparowits project have not revealed quantitatively any significant impact upon surrounding terrain."

Oil fog and plume tracer studies were conducted under conditions of unstable, neutral, and slightly stable atmospheric conditions. Stable, limited mixing, and inversion breakup conditions were examined utilizing the Intercomp Model (Intera 1974). The results are shown in Figure VIII-18. The unstable case presents conditions similar to those observed during tracer studies, and the results in Figure VIII-18 are consistent with the concentration found during the tracer tests (Intera 1974).

The highest 3-hour concentration calculated for the stable case by the Intercomp model was 36 micrograms per cubic meter ($\mu g/m^3$) at Fourmile Bench. Presently, there is no widely accepted mathematical model for calculation of ground level concentration of contaminants in a stable air mass over a complex terrain. Additional calculations were made using the Environmental Protection Agency (EPA) C7M3D model for the stable case (Figure VIII-19). The highest level calculated by C7M3D would be at Fourmile Bench with a 3-hour concentration of 185 $\mu g/m^3$ for a 2 meter per second (m/s) wind.

Highest ground level concentrations are predicted for the inversion breakup or fumigation condition using the Intercomp diffusion model. The calculated 1-hour concentration would be 232 $\mu g/m^3$, and the equivalent 3-hour concentration would be 166 $\mu g/m^3$, assuming 99.5 percent particulate control and 90 percent SO_2 control. Corresponding calculated maximum ground level concentrations of particulates, sulfur dioxide, and nitrogen oxides, and a comparison with applicable standards are shown in Figure VIII-19. Calculated levels do not differ significantly from predicted levels for Fourmile Bench. Levels would be within limitation of National ambient air quality standards and Class II limitations of Significant Deterioration Regulations. The ambient air quality standards are established at a level of pollution control necessary for the protection of human health and welfare, and, therefore, no adverse impacts to human health and welfare (which includes effects on soil, water, vegetation, animals, visibility, personal comfort and well being) would be expected.

FIGURE VIII-18

Predictions of Sulfur Dioxide Ground-Level Concentrations at Nipple Bench Under Varying Meteorological Conditions

Model	Meteorological Conditions	Location	Calculated Concentration[a] ($\mu g/m^3$)	Calculated Equivalent 3-h Concentration ($\mu g/m^3$)	Elevation (m)	Distance (km)	Wind Direction (deg)	Wind Speed (m/s)
Intercomp	Stable	Kaiparowits Plateau South End	26	19	2,310	25	248	3
	Stability Class E Plume Elevation 2,103 m	Fourmile Bench	47	36	1,800	15	148	3
		Smoky Mountain	40	30	1,700	16	260	3
C7M3D	Stable	Kaiparowits Plateau South End	64	40	1,950	43	248	3
	Stability Class E	Kaiparowits Plateau South End	12	8	2,310	45	248	3
		Kaiparowits Plateau North End	105	65	1,987	32		3
		Fourmile Bench	198	122	2,024	19	148	3
		Smoky Mountain	8	5	1,737	16	260	3
	Plume Elevation 2,020 m	Kaiparowits Plateau South End	80	50	1,950	43	248	2
		Kaiparowits Plateau South End	20	12	2,310	45	248	2
		Kaiparowits Plateau North End	138	85	1,987	32		2
		Fourmile Bench	300	185	2,024	19	148	2
		Smoky Mountain	8	5	1,737	16	260	2
NOAA	Stability Class E Plume Elevation 2,069 m	Fourmile Bench	387	290	2,024	18	260	2
Intercomp	Unstable Stability Class B Plume Elevation 2,204 m	Nipple Bench	58	44		2.3	135	5
Intercomp	Limited Mixing Stability Class B-Mixed Layer E-Inversion Layer Plume Elevation 2,204 m Inversion Base 520 m	Nipple Bench	124	93		2.3	135	5
NOAA	Limited Mixing Stability Class B-Mixed Layer	Nipple Bench	160	120		1.5		
Intercomp	Inversion Breakup Stability Class B-Mixed Layer F-Inversion Plume Elevation 2,103 m Inversion Base 550 m	Nipple Bench	232	166		2.1	135	5
	E Inversion	Nipple Bench	205			2.3	135	5

[a]One-hour averaging time. Source strength, 547 grams per second.

FIGURE VIII-19

Comparison of Air Quality Standards and Calculated Ground-Level Concentrations

Emission	Model						Natural Background Concentration ($\mu g/m^3$)	Most Restrictive Air Quality Standard ($\mu g/m^3$)	Percent of Most Restrictive Standard		
	Intercomp[a]		NOAA[b]		C7M3D[c]				Inter-comp	NOAA	C7M3D
	($\mu g/m^3$)	(ppm)	($\mu g/m^3$)	(ppm)	($\mu g/m^3$)	(ppm)					
Particulates											
Annual	1						30	10	10		
24-Hour	9		14		16		Highly Variable	30	30	47	53
Sulfur Dioxide											
Annual	2	0.001					Negligible	15	13		
24-Hour	41	0.018	66	0.025	74	0.028	Negligible	100	41	66	74
3-Hour	166	0.069	290	0.112	185	0.071	Negligible	700	24	41	26
Nitrogen Dioxide											
Annual	15	0.008					Negligible	100	15		

[a]Maximum concentrations are expected to occur at a downwind distance of 2,300 meters.
[b]Maximum concentrations are expected to occur at a downwind distance of 16 kilometers.
[c]Maximum concentrations are expected to occur at a downwind distance of 19 kilometers.
[d]Allowable increment of increase over background based on air area designation of Class II under federal regulation for prevention of significant deterioration.

Based on the recently completed Navajo studies (Rockwell International, 1975), Williams (1975) suggests that the National Oceanic and Atmospheric Administration (NOAA) E stability 2m/s model without a ground reflection would provide an adequate representation of the stable flow interactions. Based on these calculations the 3-hour SO_2 level would be 290 $\mu g/m^3$ compared with approximately 30 $\mu g/m^3$ for Intercomp. Corresponding 24-hour values would be 66 $\mu g/m^3$ compared with approximately 7 $\mu g/m^3$ for the Intercomp. The predicted levels for the NOAA model, although higher than those predicted by the Intercomp and C7M3D models are still within the limitations of the Significant Deterioration Regulations. Predicted values of Intercomp and NOAA for the limited mixing case are in close agreement - 93 $\mu g/m^3$ and 120 $\mu g/m^3$ for the short term value. Both are within the significant deterioration limitation. Particulate concentration on high terrain were calculated by Williams to be 15 $\mu g/m^3$ for the 24-hour average compared with approximately 2 for the Intercomp calculation. The 15 $\mu g/m^3$ figure represents approximately 50 percent of the Significant Deterioration Regulation.

The predicted ground level concentration under worst case meteorological conditions were used to estimate minimum emission control required to meet applicable enforceable air quality standards. Based on the fumigation case, which was determined to be the limiting case by the Intercomp model, 75.6 percent control of sulfur dioxide (SO_2) and 98.3 percent control of particulates would be required to meet the Prevention of Significant Deteioration Class II limitation. Williams calculated the 24-hour concentrations of particulates on or near high terrain would be at or near Class II standards if control equipment operated at only 99 percent instead of 99.5 percent or if significant quantities of nitrates were produced in the plume. Based on the EPA C7M3D model and the stable case, minimum control would be 86.5 and 99.1 percent, respectively. The NOAA values are inbetween the C7M3D and Intercomp values (Figure VIII-20). Emission of nitrogen oxides would be restricted by the Federal New Source Performance Standard.

FIGURE VIII-20

Percent Control of Emission Required by NSPS[a] and PSDR[b] and Corresponding Emission Rate

Control	Pollutant		
	Particulate	Sulfur Dioxide	
	24-hour	24-hour	3-hour
Percent Control Required			
NSPS	98.8	17.6	17.6
PSDR Class II			
NOAA Model Prediction	98.9	84.8	75.9
C7M3D Model Prediction	99.1	86.5	62.2
Intercomp Model Prediction	98.3	75.6	57.8
Percent Control Proposed	99.5	90.0	-
Emission Rate (ton/h)			
NSPS	1.40	17.80	17.80
NOAA	1.28	3.28	5.21
C7M3D	1.05	2.92	8.16
Intercomp	1.99	5.27	9.12
Emission Rate with Proposed Control (ton/h)	0.58	2.17	-

NOTE: Calculations based on 100 percent load, worst grade coal, and most limiting meteorological conditions.

[a]NSPS - Federal New Source Performance Standard
[b]PSDR - Federal Prevention of Significant Deterioration Regulation

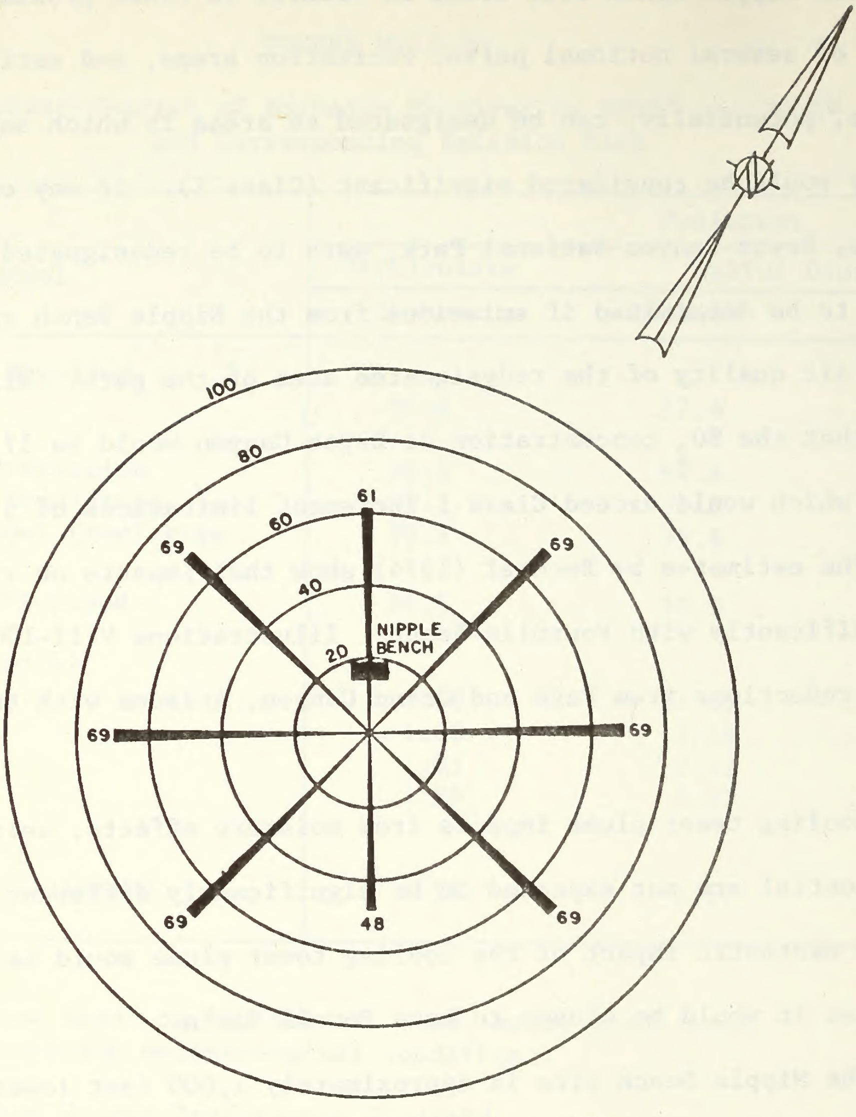
The Nipple Bench site would be located in close proximity to designated boundaries of several national parks, recreation areas, and national forests. These areas, potentially, can be designated as areas in which any deterioration in air quality would be considered significant (Class I). If any one of these areas, for example, Bryce Canyon National Park, were to be redesignated as Class I, it would have to be determined if emissions from the Nipple Bench site would significantl affect the air quality of the redesignated area of the park. Williams (1975) estimates that the SO_2 concentration at Bryce Canyon would be 17 $\mu g/m^3$ with stable conditions which would exceed Class I increment limitations of 5 $\mu g/m^3$.

The estimates by Bechtel (1974) show that impacts on visibility do not differ significantly with Fourmile Bench. Illustrations VIII-100 and VIII-101 show visibility reductions from Page and Grand Canyon, Arizona with the plant at Nipple Bench.

Cooling tower plume impacts from moisture effects, salt dispersal, and fogging potential are not expected to be significantly different than at Fourmile Bench. The aesthetic impact of the cooling tower plume would be greater at Nipple Bench because it would be closer to Lake Powell Basin.

The Nipple Bench site is approximately 1,000 feet lower in elevation than Fourmile Bench and about 15 miles nearer to the Navajo power plant. Stagnation episodes and confinement of emissions would occur slightly more frequently at Nipple Bench than at Fourmile Bench.

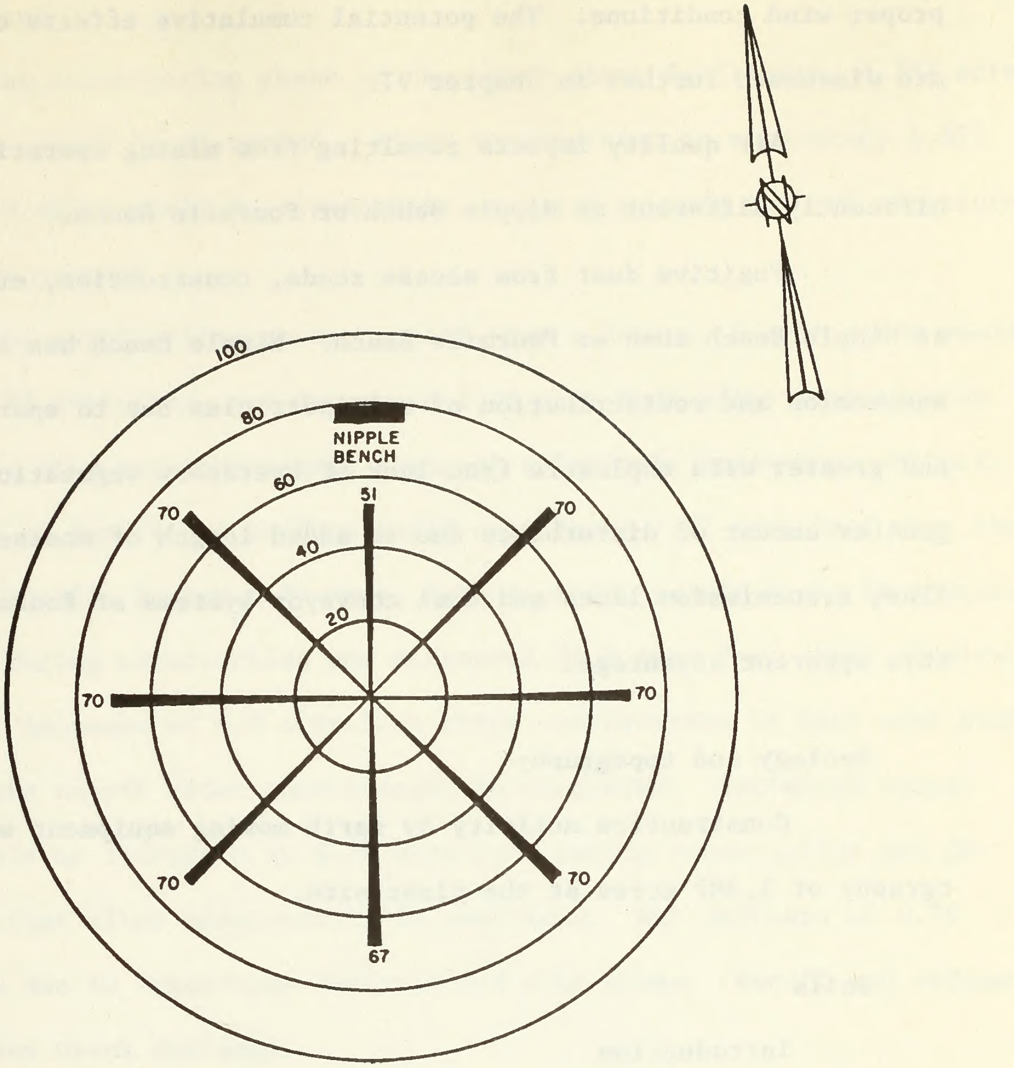
Since the Nipple Bench site would be closer to the Navajo plant than the Fourmile Bench site, the potential for plume interaction would be greater. Available meteorological data indicate that at Nipple Bench, necessary wind conditions for plume interaction occur with low frequency (about 10 percent of the time). However, actual plume interaction would probably occur less than 10 percent of the time since other meteorological events must occur simultaneously with



This illustration assumes that an observer is in the center of the rose (Page, Arizona) with the plume from a plant at Nipple Bench overhead. Looking northwest toward Nipple Bench, the visual range would be reduced from 69 miles to 61 miles. Looking southeast the visual range would be reduced from 69 miles to 48 miles.

ILLUSTRATION VIII-100

Visual Rose at Page, Arizona, With Plant at Nipple Bench
70 Mile Background Visual Range
(Frequency of Occurrence Less Than 5 Percent)



This illustration assumes that an observer is in the center of the rose (Grand Canyon) with the plume from a plant at Nipple Bench overhead. Looking north toward Nipple Bench, the visual range would be reduced from 70 miles to 51 miles. Looking south the visual range would be reduced from 70 miles to 67 miles.

ILLUSTRATION VIII-101
Visual Rose at Grand Canyon With Plant at Nipple Bench
70 Mile Background Visual Range
(Frequency of Occurrence Less Than 5 Percent)

proper wind conditions. The potential cumulative effects of Navajo and Kaiparowits are discussed further in Chapter VI.

Air quality impacts resulting from mining operations would not be significantly different at Nipple Bench or Fourmile Bench.

Fugitive dust from access roads, construction, etc., could be greater at Nipple Bench than at Fourmile Bench. Nipple Bench has a greater potential for suspension and redistribution of soil particles due to sparse vegetative cover and greater wind explosure from lack of overstory vegetation. However, the greater amount of disturbance due to added length of access roads, water pipe line, transmission lines and coal conveyor systems at Fourmile Bench could offset this apparent advantage.

Geology and topography

Construction activity by earth moving equipment would alter the topography of 1,387 acres at the plant site.

Soils

Introduction

Five components of the Nipple Bench alternative were analyzed for impacts: (1) Generating station and support facilities; (2) access highways; (3) coal mine; (4) new community; and (5) other aggregate sites. During construction an estimated 9,410 acres would be disturbed. An estimated 7,460 acres of the 9,410 acres would be permanently occupied by some type of improvement after construction is complete.

Main items considered in the analysis are possible effects of 2-year and 50-year storms of 6-hour duration, effects of salt deposition in soils from cooling tower drift and increase in sediment deposition in Lake Powell. A description of the methodology for analyses can be reviewed in the appendix to Chapter III.

Power plant

During the construction phase of the power plant facilities, 1,387 acres or 2.2 square miles would be disturbed. After construction is completed, 1,077 acres or 1.7 square miles would be permanently occupied by some type of structure, pond, disposal site or road.

During the construction phase, runoff from a 2-year, 6-hour storm would be increased by 9.57 acre-feet, and decreased 2.25 acre-feet after construction due to the presence of water impoundment areas of relatively impervious surface. However, 185 acres of impervious surface would contribute 7.32 acre-feet more than present estimated runoff. During a 50-year, 6-hour storm, runoff would be increased by 26.4 acre-feet during construction and decreased 31.2 acre-feet after construction. Reason for the net decrease of 4.8 acre-feet after construction is that pond sites would not contribute runoff after construction is completed. Estimated annual sediment yield would be increased by 0.28 acre-foot during construction and decreased 0.54 acre-foot after construction is completed. Net decrease of 0.26 acre-foot would be due to impervious surfaces and pond areas. Runoff and sediment would flow into Warm Creek Drainage.

Impacts caused by the fly ash-scrubber residue disposal site on Nipple Bench would be the same as those impacts described in Chapter III for the Fourmile Bench site. However, it would take only 3 to 4 years for side slopes to erode and a total of approximately 40 acre-feet of sediment would flow directly into Tibbet Canyon.

Deposition of salt entrained in drift from cooling towers varies from 0.5 pound per acre per year to 250 pounds per acre per year depending on distance from cooling towers. After 50 years have elapsed, salt accumulation in soil would affect approximately 865 acres of vegetation. At that time annual sediment production on the impacted area is estimated to be 0.08 acre-foot greater than present estimated sediment production. Vegetative cover would be reduced an average 50

percent on salt accumulation acres. Sodium absorption ratio (SAR) for salt deposit in soil is 2.42 - not considered detrimental to vegetative growth from a sodium hazard standpoint.

Actual deposition of salt on foilage could possibly be detrimental to vegetation. However, it is not known at this time whether defoliation would occur or growth would be inhibited.

Effects of trace elements on the soils on Nipple Bench would be the same as on Fourmile Bench - of no consequence.

Sediment and runoff would flow into either Tibbet Canyon or Nipple Creek. Probability of seeding success would be 3 to 5 years out of 10 years.

Water pipe line

During the construction phase of the water pipe line, 325 acres or 0.50 square mile would be disturbed. After construction is completed, 120 acres or 0.19 square mile would be occupied by pipe line, access roads, patrol roads, conveyor systems and power lines.

During construction, estimated runoff from a 2-year, 6-hour storm would be increased by 1.4 acre-feet and increased another 0.8 acre-foot after construction. This is 2.2 acre-feet higher than present runoff estimates. This increase would be due to the packed surface of patrol roads. During a 50-year, 6-hour storm, estimated runoff would be increased 4.4 acre-feet during construction and increased another 2.3 acre-feet after construction is completed. This is 6.7 acre-feet higher than present runoff estimates.

Estimated annual sediment yield would be increased by 0.03 acre-foot during construction and decreased 0.01 acre-foot after construction. This would be 0.02 acre-foot higher than present annual sediment yield estimates. Initial reduction in sediment yield would be due to restoration of disturbed areas. However, the additional 0.02 acre-foot of sediment occurring after construction

would be due to water from road surfaces moving down slopes and borrow areas. Runoff and sediment from pipe line construction would flow into Warm Creek Drainage, whereas runoff and sediment from the access road would flow into Wahweap Creek Drainage.

Aggregate sites and access road

An existing jeep trail would have to be reconstructed for access into the proposed aggregate site on upper Wahweap Creek. The aggregate pit would be confined to the creek bed and would not affect runoff and erosion. Open pits in the creek bed would act as settling basins whenever a storm occurs.

After a few storms, all traces of aggregate pits would be obliterated. As long as no channel straightening occurs, there would not be any damage to the downstream channel or Lake Powell. However, should channel straightening take place, Wahweap Creek would erode back towards the upper reaches of the drainage system resulting in sediment deposition in lower portions of Wahweap Creek and Lake Powell. Time involved and amount of damage that would take place cannot be evaluated because of complexity of the drainage system and inconsistency of storm patterns.

The access road to the aggregate pit would require disturbance of 15 acres or 0.023 square mile. After construction is completed, 10 acres or 0.016 square mile would be occupied by road surface and borrow areas.

During construction, runoff from a 2-year, 6-hour storm would be increased by 0.04 acre-foot and increased another 0.18 acre-foot after construction. Runoff after construction would be 0.22 acre-foot greater than present estimates. At least half of the net increase in runoff would occur in sagebrush areas.

Runoff from a 50-year, 6-hour storm would be increased by 0.4 acre-foot during construction and increased another 0.3 acre-foot after construction is completed. Runoff after construction would be 0.7 acre-foot greater than present

estimates. As with the 2-year storm, at least half of the net increase in runoff would occur in sagebrush areas.

Estimated annual sediment yield would be increased by 0.006 acre-foot during construction and decreased 0.003 acre-foot after construction is complete. Estimated annual sediment yield after construction would be 0.003 acre-foot greater than present estimates. The majority of sediment yield increase would occur along borrow areas within sagebrush stands. All runoff and sediment production would flow into Wahweap Creek.

New highway

During construction of the highway, 430 acres or 0.67 square mile would be disturbed. After construction is complete, 300 acres or 0.47 square mile would be occupied by road surface and borrow areas.

During construction, runoff from a 2-year 6-hour storm would increase by 3.0 acre-feet and increase another 0.5 acre-foot after construction. Runoff after construction is completed would be 3.5 acre-feet greater than present yield. Greatest amount of runoff would occur on that portion of highway to Nipple Creek and the segment crossing Wesses Canyon and Pilot Knob to the coal mine.

Runoff from a 50-year, 6-hour storm would be increased by 5.6 acre-feet during construction and increased another 2.0 acre-feet after construction. Runoff after construction would be 7.6 acre-feet greater than present estimates. As in the case of the 2-year, 6-hour storm, greatest amount of runoff would occur along the Nipple Creek, Pilot Knob and Wesses Canyon segments.

Estimated annual sediment yield would be increased by 0.06 acre-foot during construction and decreased 0.03 acre-foot after construction. This is still 0.03 acre-foot higher than present annual sediment yield estimates. The additional 0.03 acre-foot of sediment occurring after construction would be due to water from road surfaces moving down slopes and borrow areas, particularly on the

Nipple Creek, Pilot Knob and Wesses Canyon segments. Runoff and sediment from the Glen Canyon City-Nipple Bench highway would flow into Wahweap Drainage. Majority of runoff and sediment from Nipple Spring to Fourmile Bench would flow into Warm Creek Drainage.

Nipple Creek, Pilot Knob and Wesses Canyon segments are most sensitive to erosion and runoff because of moderately steep slopes with shallow and fragile soils.

Impact to the Paria River Drainage would be the same as that described in the Fourmile Bench proposal.

Coal mine

During construction of coal mine facilities, 1,814 acres or 2.8 square miles would be disturbed. After construction is complete, 1,636 acres or 2.6 square miles would be permanently occupied by roads, buildings, ponds, refuse dumps, mine portals, and conveyors.

During construction, runoff from a 2-year, 6-hour storm would increase by 2.6 acre-feet, and increase an additional 13.4 acre-feet after construction is completed. Total increase in runoff would be 16 acre-feet compared to present runoff estimates. This increase would be caused by impervious surfaces on buildings, roads, and protective structures.

Runoff from a 50-year, 6-hour storm would be increased by 22.6 acre-feet during construction and increased another 5.2 acre-feet after construction. Total increase in runoff for a 50-year, 6-hour storm would be 27.8 acre-feet when compared to present estimates. Increased runoff would be caused by impervious surfaces on buildings, roads, and protective structures.

Estimated annual sediment yield would be increased by 0.3 acre-foot during construction and decreased 1.2 acre-feet after construction. Net decrease in sediment yield compared to the present estimate would be 0.9 acre-foot.

Impervious areas account for the net decrease in sediment production. All runoff and sediment would flow into Warm Creek Drainage.

New community

During the construction phase, 5,000 acres would be disturbed, of which approximately 50 percent would be permanently occupied after construction by impervious surfaces in the form of streets, sidewalks, driveways, rooftops and patios.

During construction, the maximum runoff from a 2-year, 6-hour storm would be increased by 4.5 acre-feet and increase an additional 26.3 to 46.8 acre-feet after construction is complete. The total increase would be caused by impervious surfaces associated with the new community.

Runoff from a 50-year, 6-hour storm would be increased 95.0 acre-feet during construction and increased an additional 52.5 to 97.3 acre-feet after construction is completed. Total increase in runoff would be 147.5 to 192.3 acre-feet when compared to present estimates. The total increase would be caused by impervious surfaces associated with the new community.

Estimated annual sediment yield would be increased by 1.0 acre-foot during construction and decreased 0.5 acre-foot after construction is completed. Net increase in annual sediment yield following construction would be 0.5 acre-foot. Decrease in sediment yield from construction phase to completion phase would be attributable to impervious surfaces, which would have a tendency to stabilize soil surface. However, net increase in annual sediment yield after construction would take place in natural drainages where runoff water would flow into Wahweap Creek.

Water that would be used by the new community to irrigate landscaping is not considered detrimental to soil. Electrical conductivity of the water is 477 micromhos (EC x 10^6), indicating a low to medium salinity (soluble salts) hazard.

The sodium absorption ratio (SAR) for the water was determined at 3.1, which indicates a low alkali (exhangeable sodium) hazard (Richards, 1954). Indicated hazards are too low to inhibit growth of native vegetation or any introduced species.

Soil suitability for septic tank fields, sewage lagoons, sanitary land-fill, dwellings, roads and streets for East Clark Bench would be the same as described in Chapter III.

Summary of impacts

Individual effects of runoff and sediment production were identified earlier in this section. However, possible cumulative effects of runoff and sediment on various drainages and Lake Powell, should be discussed.

For a 50-year, 6-hour duration storm, during construction, runoff would be an additional 110 percent of normal. After construction is complete, runoff would be an additional 45 to 77 percent of normal because of large areas of impervious surfaces. However, on 865 acres affected by salt accumulation from cooling tower drift, additional runoff water could be expected to flow into Warm Creek. If the 50-year storm occurred after 50 years have elapsed, potential run-off would be 50 percent greater than present estimates.

Runoff from the salt accumulation area for a 2-year, 6-hour duration storm would be significantly increased after 50 years have elapsed. Runoff would increase 33 percent since ground cover would have decreased 25 percent. Runoff in Warm Creek Drainage would be increased 1.4 percent during construction and 2.5 percent after construction. Runoff in Wahweap Drainage would increase 0.4 percent during construction and 1.8 to 2.8 percent after construction. Total increased runoff into Lake Powell would be 0.7 percent during construction and 2.0 to 2.7 percent after construction. Increased runoff is attributed to access roads and impervious surfaces. Note in each case the increased quantities of runoff into

Wahweap Creek, Warm Creek and Lake Powell are less than 3 percent and, therefore, would not have a significant impact, either adverse or favorable.

During construction, sediment yield would increase 29 percent and decrease 8 percent after construction is complete. However, this is misleading as the borrow areas along roads, which receive increased amounts of runoff, would be eroding at a faster rate than the present situation, particularly along the highway up Nipple Creek, Pilot Knob and Wesses Canyon. After 50 years have lapsed, annual sediment yield from the plant site including the salt accumulation area would still be 80 percent of present estimates.

During construction, annual sediment yield would be increased 0.5 percent in Warm Creek Drainage, 0.4 percent in Wahweap Creek Drainage and 0.5 percent in Lake Powell. The increase for Lake Powell assumes that all other variables in other portions of the lake would remain constant. After construction is complete, sediment load in Warm Creek Drainage would decrease 0.90 percent, increase 0.2 percent in Wahweap Creek Drainage, with a net decrease in Lake Powell of 0.1 percent. These results do not reflect localized problems along access roads and highways. Increased sediment yields are less than 1 percent and therefore not significant.

With the exception of Wahweap Creek Drainage, there would be a net decrease of 12.9 acre-feet in accumulative sediment deposition in Warm Creek and Lake Powell over a 50-year period. However, this decrease does not reflect localized problems of highways and roads along Pilot Knob and Wesses and Missing canyons. Increased sediment in Wahweap Creek, would be attributed to the new community on East Clark Bench, the new highway along Nipple Creek and the proposed access road to the aggregate site.

It is not known if reduction of sediment deposition in Lake Powell would result in a reduction of nutrients for phytoplankton which in turn are a

source of food for fish and other aquatic species. Reduction of sediment would definitely benefit spawning habitat.

The above analysis assumes there would be no subsidence in the coal mine area, nor channel straightening during extraction of aggregates in upper Wahweap Creek and that drift rate for salt entrained in water from cooling towers would be 0.01 percent.

If subsidence did occur in the coal mine area, estimated storm runoff and sediment yield would be reduced proportionally to the area subsiding. This would result in further sediment reduction in Warm Creek Drainage.

If the drift rate from cooling towers were reduced by two to ten times, sediment from surface disturbance would increase during construction of additional evaporation ponds. This would result in a net decrease in storm runoff and sediment yield in Warm Creek Drainage after construction has been completed. Also, effects of salts on soils and vegetation would become negligible, resulting in further decreases in storm runoff and sediment yield to Warm Creek and Lake Powell.

If channel straightening occurred along upper Wahweap Creek, sediment deposition to the Wahweap arm of Lake Powell could be increased two to ten times over a multi-year period with the annual rate accelerating as each year passes.

If a new community was established and the power plant built, additional deterioration to Warm Creek, Wahweap Creek and Last Chance drainages would occur. This deterioration would be from recreation and off-road vehicles traversing the area and compacting soils, thus depleting vegetative cover and increasing the annual rate of sediment deposition in Lake Powell. As indicated in the previous analysis, initial sediment deposition would occur in the Warm and Wahweap Creek drainages. However, if the new community and power plant are established, then sediment deposition would occur in Last Chance Creek Drainage. Because of the possible larger areas that would be affected by recreational activities, sediment deposition in Lake Powell from all three drainages would exceed those estimates

for the construction phase. However, because of lack of knowledge on which areas would be affected, it is impossible to quantify potential impact.

Water resources

Disturbance and occupation of Nipple Bench would result in greater amounts of runoff water and less sediment yield when compared to Fourmile Bench.

Reduction in length of the water pipe line and access highways would reduce sediment and runoff accordingly. The coal mine, new community, and aggregate access road impacts to water quality and sediment deposition in Lake Powell, would be negligible.

The ash disposal area would not be on a poorly permeable mudstone deposit (as at Fourmile Bench) and, therefore, contaminants from the ash disposal area could seep more readily to underlying aquifers. Also, there is a possibility that leakage of contaminants from this source and the evaporation ponds would reach Lake Powell more readily. Construction of the facilities on Nipple Bench could disrupt the flow from Tibbett and Nipple springs or necessitate their being diverted to another point of discharge. Extent or possibility of these impacts is not known at this time.

Vegetation

During construction, an estimated 9,410 acres of vegetation would be disturbed. An estimated 7,460 acres of this vegetation would be removed and the area occupied by some type of man-made structure after construction of the power plant, water pipe line, access highway, new community, coal mine, aggregate sites and access roads. The Nipple Bench proposal would disturb 1,387 acres, which is 215 acres more than the Fourmile Bench proposal. It would occupy 1,077 acres after construction is completed, which is 145 acres more than the Fourmile Bench proposal.

Stack emissions would have a negligible effect on vegetation, whereas salt accumulation resulting from cooling tower drift could reduce vegetative cover in the salt drift area by as much as 50 percent.

Wildlife

Wildlife adversely affected by the Nipple Bench proposal would be primarily small mammals, songbirds, reptiles and the coyotes and birds of prey they support. Loss of wildlife habitat due to vegetation loss and other disturbances would reduce populations of small prey animals. This would adversely affect the predators that depend on these animals as a source of food.

Ecological interrelationships

The measureable adverse effect on ecological interrelationships would be that on 865 acres subjected to salt accumulation from cooling tower drift, based on present drift rate estimates, vegetative cover could be reduced by 50 percent.

Another disruption to ecological interrelationships would be the use of off-road and recreation vehicles in remote fragile areas. Most of this use could be attributed to residents from the new community and, therefore, would be similar for any plant site selected. Annual erosion rates could increase at far greater rates than presently estimated for the construction phase. Presence of motorized vehicles in remote canyons could inhibit nesting and reproduction of some birds of prey and encourage harassment of other wildlife. Deterioration of vegetation and soils and impacts on wildlife by indiscriminate off-road vehicle use cannot be evaluated at this time. Small native mammals presently residing on Nipple Bench probably would face some increased competition from introduced rats and mice.

Paleontology

Limited surveys on Nipple Bench revealed three paleontological sites of some scientific value. Fragments of turtle shells and dinosaur bones are found and crocodile teeth and plant impressions occur within the Wahweap sandstone. All paleontological values are of some importance as they provide information on species evolution, migration, and range. However, the loss of paleontological remains at the Nipple Bench plant site would be minimal. The isolated finds are fragmented examples of paleontological values and common throughout the area.

Archaeology

Thirty-five archaeological sites occur. Fifteen scientifically important archaeological sites occur within the confines of the plant site area and 20 in the 1/2 mile buffer zone agreed upon for purposes of study and impact. Five of these sites would be directly affected by the proposed activities, i.e. plant facilities and disposal areas, and the remainder by secondary impacts. A thorough intensive survey would be needed with relocation of facilities where feasible and salvage considered where necessary.

Recreation

Recreation impacts resulting from the Nipple Bench alternative would be basically the same as those described for the Fourmile Bench proposal. There would be lesser impacts to the aesthetics due to shorter pipe lines and highways. Hunting and sightseeing that takes place on Nipple Bench would be lost to the public.

Land use

Livestock

A grazing allotment of 948 AUMs would be no longer available to one livestock operator.

Mineral

There would be no adverse impacts to minerals as there are no known mineral deposits on Nipple Bench.

Wood products

There are no wood products on Nipple Bench.

Agricultural lands

There are no agricultural lands on Nipple Bench.

Transportation

Access would be improved to Nipple Bench.

Transmission facilities

Nipple Bench to Eldorado alternate

Environmental impacts of this proposed alternate route are the same as those discussed for the Fourmile site except there are no pinyon or juniper trees at the Nipple Bench site. Consequently, less clearing for the power line will be required.

This route would be shorter than that from the Fourmile Bench site and has the advantage of being the most direct routing between the plant site and a tie-in with the proposed Fourmile Bench transmission line system, thereby minimizing transmission line and access road construction costs and environmental impacts on Nipple Bench and Wahweap Basin areas. Impacts on this alternate route would be the same as the East Clark Bench alternate, described in this chapter.

Alternate from Nipple Bench to Navajo generating station, Westwing substation and Mohave generating station

This alternate route would cause the same environmental impacts as those discussed for the John Henry alternate and proposed routes from Fourmile Bench to Navajo generating station, Westwing substation, and Mohave generating station.

Ty Hatch alternate

The same access road problems exist with this route as with the proposed route where the route would descend the cliffs to Wahweap Basin. This route would be about 3 miles longer than the proposed route, and require six more angle towers. Crossing the Wahweap Basin would subject the line to more natural hazards of flooding and unstable tower footings than the direct crossing followed by the proposed route. This route would, however, be a suitable alternate in the event the first 5 miles of the proposed route were utilized for the Kaiparowits-Moenkopi line.

Wahweap alternate

Impacts resulting from the Wahweap alternate would be the same as those from the proposed Nipple Bench to Eldorado route and proposed routes from Fourmile Bench.

Mitigation of environmental impacts and unavoidable adverse impacts

Generating plant facilities

Mitigating measures

The mitigation measure discussed in Chapter IV would also be implemented if the generating plant was built on the Nipple Bench site.

Any adverse effects which cannot be avoided should the proposal be implemented

Unavoidable adverse impacts within the Kaiparowits Plateau impact area resulting from increased population and development would occur if the generating station were to be built at either the Nipple Bench site or the Fourmile Bench site. These adverse impacts common to both sites are discussed in Chapter V and are not repeated here.

An unavoidable degradation of existing air quality would occur at Nipple Bench. Air quality problems would be greater than at the proposed site at Fourmile Bench. The Nipple Bench site is approximately 1,000 feet lower in elevation than Fourmile Bench and about 14 miles closer to Navajo power plant. Stagnation episodes and confinement of emissions would occur slightly more frequently at Nipple Bench than at Fourmile Bench. Based on available data, although air quality would be affected during stagnation conditions, present air quality standards would not be exceeded.

Since Nipple Bench would be closer to the Navajo plant than Fourmile Bench, the potential for plume interaction would be greater. Available meteorological data indicate that necessary meteorological conditions for plume interaction would occur about 10 percent of the time.

If the generating station were to be built at Nipple Bench, certain unavoidable impacts would occur there rather than Fourmile Bench. Construction would permanently eliminate 1,077 acres of vegetation at the Nipple Bench site. Vegetation on another 865 acres could be reduced up to 50 percent after 50 years

due to salt accumulation in the soil. Vegetation losses would reduce available food and cover for wildlife species such as blacktailed jackrabbits and other nongame animals. This would reduce available food for coyotes and birds of prey. However, mule deer habitat would not be eliminated by the Nipple Bench site as would occur at Fourmile Bench.

Unavoidable alterations in topography on 1,387 acres would occur at the Nipple Bench site. Minimal hunting and sightseeing would be lost. The loss of paleontological and archaeological values would be minimal and information would be obtained from survey and salvage operations. A grazing allotment of 948 AUMs would be no longer available to one livestock operator.

Transmission facilities

Nipple Bench to Eldorado

Mitigating measures

Measures that would mitigate adverse impacts in this area are essentially the same as those for the proposed line from Fourmile Bench to Eldorado. An additional measure that would be needed to control access to tower locations as far west as Mile 3 from the plant site. However, it appears that an access road down the cliffs at Mile 3 is not advisable because of steep and unstable terrain which would make road construction and maintenance difficult and scarring would result. Access to tower locations west of the cliffs should be required to be made from the south, using access roads for the proposed Kaiparowits-Moenkopi transmission line system.

Any adverse effects which cannot be avoided should the proposal be implemented

The unavoidable adverse effects related to this route are the same as those discussed for the Fourmile Bench site in Chapter III.

Alternate routes from Nipple Bench to Navajo generating station, Westwing substation and Mohave generating station

Mitigating measures

Mitigating measures for the alternate route from Nipple Bench would be the same as mitigating measures for the John Henry alternate and the proposed routes from Fourmile Bench.

Any adverse effects which cannot be avoided should the proposal be implemented

Unavoidable adverse effects resulting from the proposed route from Nipple Bench would be the same as those resulting from the John Henry alternate and proposed routes from Fourmile Bench.

Ty Hatch alternate

Mitigating measures

Mitigation measures would be the same as those for the proposed action.

Any adverse effects which cannot be avoided should the proposal be implemented

Unavoidable adverse effects would be similar to those discussed in Nipple Bench to Eldorado alternate above.

Wahweap alternate

Mitigating measures

Mitigating measures for the Wahweap alternate would be the same as mitigating measures for the proposed Nipple Bench to Eldorado route and proposed routes from Fourmile Bench.

Any adverse effects which cannot be avoided should the proposal be implemented

Unavoidable adverse effects resulting from the Wahweap alternate would be the same as those resulting from the proposed Nipple Bench to Eldorado route and proposed routes from Fourmile Bench.

FIGURE VIII-21

SITE COMPARISON STUDY - FOURMILE AND NIPPLE BENCH
Environmental Considerations

Factors	Fourmile Bench Site		Nipple Bench Site	
Average annual rainfall	8 to 9 inches		7 to 8 inches	
Frost-free days	150		160	
Potential evapotranspiration	27 to 30 inches		30 to 33 inches	
Prevailing winds	Southwest and west		Southwest and west	
Elevation of plant site	6,200 feet above mean sea level		5,200 feet above mean sea level	
Stack height	600 feet		800 feet	
Stack emissions and rates	Similar for both sites			
Predicted ground level concentrations (fumigation conditions)	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm
Particulates				
Annual	1		1	
24-hour	10		9	
Sulfur dioxide				
Annual	2	0.009	2	0.001
24-hour	45	0.020	41	0.018
3-hour	181	0.080	166	0.069
Nitrogen dioxide				
Annual	15	0.0080	15	0.0080
Stagnation episodes	2 to 3 episodes per year		Slightly higher	
Average stagnation episode	5 to 7 days		5 to 7 days	
Predicted plume opacity	11 percent		13 percent	
Emission effects on visibility	Similar for both sites			
Potential for plume entrapment by elevated inversion layer and ground level effects from limiting mixing	Slightly greater potential at Nipple Bench than at Fourmile Bench			
Potential for plume interaction with elevated terrain	Greater potential at Nipple Bench than at Fourmile Bench			
Cooling tower plume rise	Similar for both sites			
Cooling tower fogging potential	Similar for both sites			
Drift rate from cooling towers	Similar for both sites			
Distance from Grand Canyon	76 miles		70 miles	
Distance from Navajo Power Plant	36 miles		21 miles	
Potential for plume interaction with Navajo Power Plant	Slightly greater at Nipple Bench, but low probability for both sites			
Total acres disturbed during construction	9,460		9,410	
Total acres occupied by structures and improvements after construction completed	7,320		7,460	
Change in annual sediment deposition into Lake Powell, compared to present conditions: During construction	+ 1.9 acre-feet		+ 1.7 acre-feet	
After construction	- 0.5 acre-foot		- 0.5 acre-foot	
Potential number of acres that could be adversely affected by salt deposition from cooling tower drift	1,375		865	
Potential percent reduction in vegetative cover	70 percent		50 percent	
50-year change in cumulative sediment deposition in Lake Powell, proposed compared to present conditions	- 26.0 acre-feet		- 12.9 acre-feet	
50-year change in annual sediment yield on area of salt accumulation, proposed compared to present conditions	+ 0.29 acre-foot		+ 0.08 acre-foot	

Factors	Fourmile Bench Site	Nipple Bench Site
Types and potential numbers of wildlife that could be lost due to presence of the power plant after 50 years have lapsed	20 head of deer year long or 70 head of deer during the winter, and numerous small mammals, raptors, reptiles, birds and predators	Numerous small mammals, reptiles, and a few birds
Loss of unique biological features	Pinyon and juniper trees at least 500 to 700 years old, one being over 1400 years old	Negligible
Impact on paleontological values	Encompasses the Kaiparowits formation that contains numerous fossils on 13 sites	Encompasses the Wahweap and Straight Cliffs sandstones that contain three sites with fossil fragments of turtle shells, dinosaur bones, and crocodile teeth
Impact on archaeological values	50 archaeological sites recorded, 30 within proposed plant site, and 20 within half-mile buffer zone, reflecting limited and specialized activities. 7 would be disturbed.	35 archaeological sites, 15 within proposed plant site and 20 within half-mile buffer zone, exhibiting complex associations of features and artifacts. 5 would be disturbed.
Effect on surface water quality	The effect would be the same regardless of the site chosen.	
Effect on ground water quality	The effect would be the same for both sites, as the ground water would be influenced by the mining operation on John Henry Bench and the new community on East Clark Bench.	
Loss of livestock grazing	740 AUM's per year	948 AUM's per year
Visibility of power plant, indicating aesthetic impact on region	Power plant complex in full view from Bryce Canyon National Park, 32 miles away. Top of stack visible from Page, Arizona, 32.5 miles away. None of power plant complex visible from Glen Canyon City, Utah, or Warm Creek Basin and Wahweap Marina on Lake Powell.	Top of stack visible from Bryce Canyon National Park, 40 miles away, Page, Arizona, 18.5 miles away, and Highway U-89, 10 miles away. Top of stack may also be visible from some portions of Lake Powell. None of power plant complex visible from Glen Canyon City, Utah, or Warm Creek Basin and Wahweap Marina on Lake Powell.
Coal underlying power plant site that would be lost during life of project	92 million tons	Negligible
Potential loss of wood products due to location of power plant	1,170 acres of trees suitable for firewood and posts	None
Potential impact on agricultural lands	There are no lands of agricultural value on Fourmile Bench or Nipple Bench.	
Access highway needed	67 miles	71 miles
Access roads for pipeline and power plant needed	60 miles	45 miles
Water pipeline needed	32 miles	19 miles
Change in elevation from coal mine to power plant site	+ 1,200 feet	+ 200 feet
Conveyor way needed	13 miles	14 miles
Rock tunnels needed	0.6 miles	1.2 miles
Transmission lines to be built	1,457 miles	1,443 miles

OTHER ALTERNATIVE GENERATING STATION SITES - KAIPAROWITS PLATEAU

From 1964 to 1973, Southern California Edison and Arizona Public Service companies examined 19 potential generating sites in Utah and Arizona (Illustration VIII-102). In conducting siting studies, the companies considered technological, economic, and environmental factors. Distance that coal and water would have to be conveyed to any site was of major concern. An attempt was made to exclude consideration of any site within 6 miles of Bryce Canyon National Park, Capitol Reef National Park, Devil's Garden Outstanding Natural Area, Escalante Outstanding Natural Area, Glen Canyon National Recreation Area, and Dixie National Forest. Site studies also avoided coal lease areas.

Once potential areas were defined, air quality and line-of-sight profiles from critical locations to the power plant were major criteria for selection. Field reconnaissance, preliminary engineering studies, and order of magnitude cost estimates were included in the feasibility studies. The company task force presented a report July 28, 1964, which recommended consideration of four sites relatively close to Lake Powell. Subsequent discussions with the National Park Service, passage of the Clean Air Act in 1970, and meteorological studies of selected sites prompted the companies to consider sites on the nearby benches as alternatives. Nipple Bench was chosen as more favorable than lower sites because of reduced visibility from Page, Wahweap Marina, and Lake Powell, and more favorable conditions for dispersion of stack emissions. Environmental monitoring and related studies were initiated in preparation for an environmental report.

In June 1973, after discussions with members of his staff and others, the Secretary of the Interior denied the applications that had been submitted for the proposed Kaiparowits generating station, primarily for environmental reasons. These environmental concerns included proximity of the plant site to the Glen Canyon National Recreation Area and Lake Powell, and proximity of the proposed

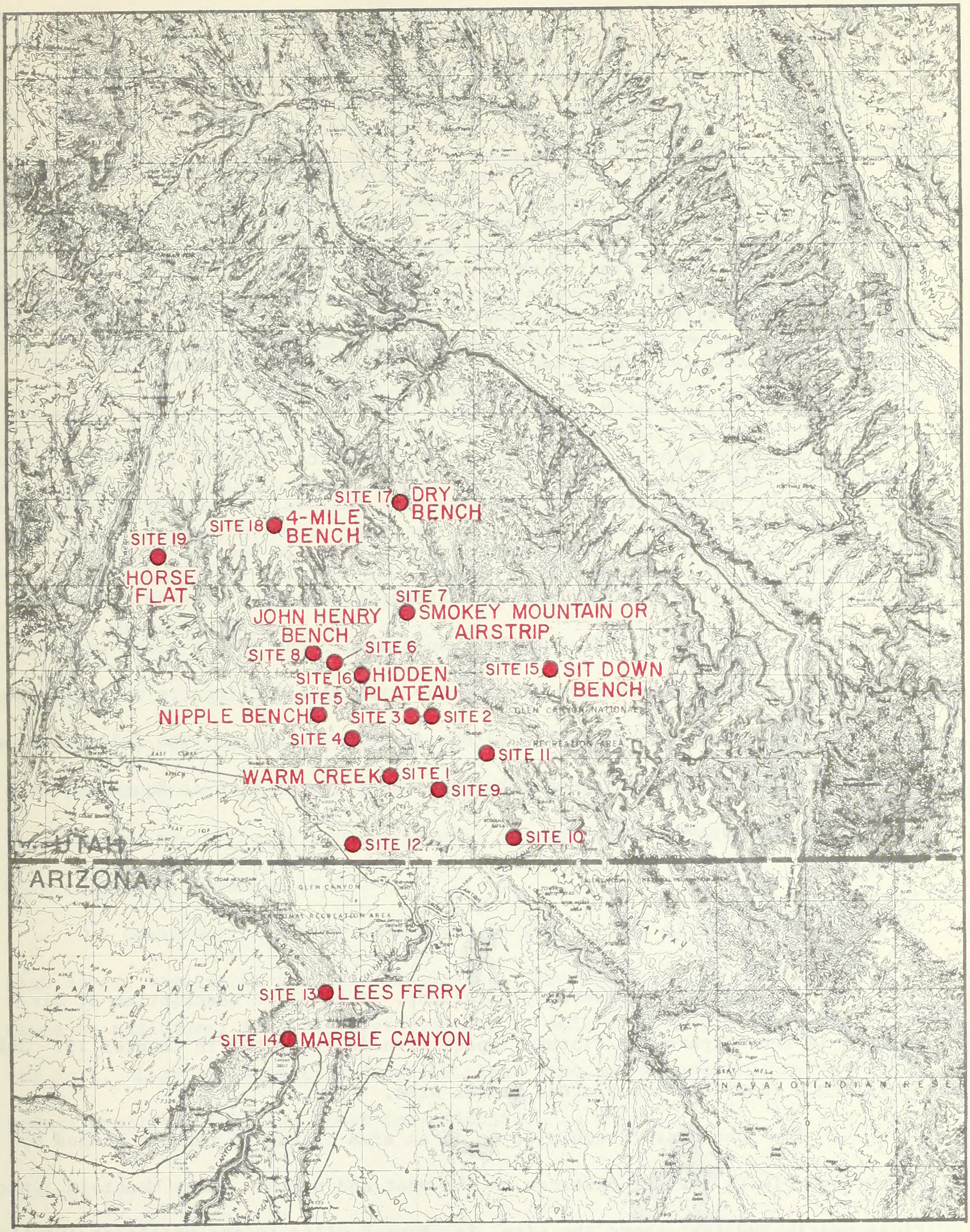


ILLUSTRATION VIII-102

Generating Station Site Area Selection

power plant site to the Navajo power plant site under construction near Page, Arizona. This decision was made by the Secretary prior to submission to him of the companies' environmental report for Nipple Bench.

After reviewing the environmental report, the Secretary agreed that he would consider a power plant proposal for a site farther removed from these two areas of concern. Accordingly, the companies initiated a siting study north of the Nipple Bench site on the Kaiparowits Plateau. As a result of these additional studies, the companies identified four proposed sites: Dry Bench (Site 17), Fourmile Bench (Site 18), Horse Flat (Site 19), and John Henry Bench (Site 8).

A comparison of some important environmental aspects for the John Henry Bench site, Dry Bench site and Horse Flat site follows. Generally, these sites have many similarities to the proposed site at Fourmile Bench. Since these three sites are also within the Kaiparowits Plateau, most of the impacts reported for the plateau impact area in Chapter III would also occur if the plant were located at any one of these alternative sites. Any site specific impacts would obviously occur at the alternative site rather than at Fourmile Bench. The following comparison emphasizes the differences between the proposed site at Fourmile Bench and the three alternative sites.

John Henry Bench

Air quality

Air quality is generally excellent. A complete description of air quality in the Kaiparowits Plateau impact area is presented in Chapter II. John Henry Bench is within the plateau impact area.

The John Henry Bench site is in an area of rugged terrain ringed by 1,000-foot bluffs a short distance to the west and north. Smoky Mountain, which rises nearly 500 feet above the site, is about 6 miles to the northeast (Southern California Edison Company, November 1973).

The proximity of high, rugged terrain in the vicinity of the proposed site could cause some air quality problems. The participants identified two potential dispersion problems: plume downwash from winds moving over nearby elevated terrain areas, and trapping of stack emissions by nearby high terrain and infrequent occurrence of elevated stable air layers. The participants estimated that a stack height of about 1,000 feet would be required at this site in order to release stack emissions above nearby terrain features. The complexity of the terrain in the immediate area would necessitate extensive meteorological studies to quantify the nature and extent of the above considerations. No detailed meteorological studies have been conducted on John Henry Bench. However, during plant siting studies the participants did conclude John Henry Bench was less favorable than Fourmile Bench in terms of plume visibility, plume dispersion, and potential for plume interaction with the Navajo power plant (Southern California Edison Company, November 1973).

Biology

Vegetation on John Henry Bench is a diverse high desert shrub community. The wide variety of perennial shrubs and grasses is valuable as winter and summer food sources for big game animals as well as many small animals (Southern California Edison Company, November 1973).

Construction of the generating facility would eliminate the existing high desert vegetation from the plant site. Operation of the cooling towers would cause an additional loss of vegetation due to salt drift and salt accumulation in the soil. Loss of vegetation from the plant site and surrounding areas would reduce available food and cover for wildlife.

Archaeology

A single light scatter of chalcedony and jasper flakes was found on the south side of this site. Other similar archaeological materials would probably

occur on and immediately adjacent to the site. No known sites of ancient human habitation were located on this site (Southern California Edison Company, November 1973).

Construction of the generating facility would cause the loss of archaeological materials within and nearby the plant site. Existing information indicates this loss would be minimal, especially after salvage operations.

Site geology/seismology

John Henry Bench is relatively free from any major seismic activity. However, because of the close proximity of the coal mine, there is a potential for subsidence of 15 to 18 feet. A thin layer of soil overlays sedimentary rock consisting of the Wahweap formation, interbedded mudstone, siltstone, resistant and non-resistant sandstone, and conglomerate (Southern California Edison Company, November 1973).

Construction activity by earth-moving equipment would disrupt the soil and alter the topography at the plant site and surrounding areas.

Water quality

Water quality of ground and surface water at John Henry Bench is characteristic of the Kaiparowits Plateau as described in Chapter II. Disposal of waste materials such as fly ash and scrubber sludge would pose a threat to water quality.

Dry Bench

Air quality

Air quality is generally excellent. A complete description of air quality in the Kaiparowits Plateau impact area is presented in Chapter II. Dry Bench is within the plateau impact area.

The Dry Bench site is in a canyon surrounded in all directions except to the south by terrain approximately 1,000 feet higher than this alternative

plant site. In addition, the Kaiparowits Plateau rising to over 2,000 feet above the plant site is located 12 miles northeast of the site (Southern California Edison Company, November 1973).

Plume downwash and trapping effects could occur because of the terrain setting at this site location. In addition, since the site is located in a major water drainage area, it could be expected that stack emissions would be transported by local air drainage winds toward Lake Powell in higher concentrations than from Fourmile Bench and have a greater possibility of interacting with emissions from the Navajo plant. A stack height of 1,000 feet would be required at this site. As with the John Henry Bench site, extensive meteorological studies have not been initiated and would be required. During plant siting studies the participants concluded Dry Bench was less favorable than Fourmile Bench in terms of plume visibility, plume dispersion, and potential for plume interaction with the Navajo power plant (Southern California Edison Company, November 1973).

Biology

The plant community on Dry Bench is a transition zone of pinyon-juniper and big sagebrush. Several species of shrubs and herbs are present throughout the area. This area appears to be part of a deer winter range. However, extent of use is unknown (Southern California Edison Company, November 1973).

Dry Bench contains an overlap of high desert and low mountain plant and animal communities. The increased habitat diversity resulting from this overlap increases the biological value of this area.

Construction of the generating facility would eliminate the existing vegetation from the plant site. Operation of the cooling towers would cause an additional loss of vegetation due to salt drift and salt accumulation in the soil. Loss of vegetation from the plant site and surrounding areas would reduce available food and cover for wildlife.

Archaeology

A light scatter of chalcedony and basalt flakes, similar to the one recorded at John Henry Bench, was found at this site. Additionally, an isolated projectile point was found. There is a possibility that pine nut harvest camps and winter villages occur on the site (Southern California Edison Company, November 1973).

Construction of the generating facility would cause the loss of archaeological materials within and nearby the plant site. Destruction of this little-studied site would cause the loss of a nonrenewable resource. Further study and salvage operations would be necessary to mitigate archaeological losses.

Site geology/seismology

Dry Bench is relatively free from any major seismic activity. A thin layer of soil overlays sedimentary rock consisting of Straight Cliffs Formation (Drip Tank member) - containing mainly fine-to-medium grained cross stratified sandstone (Southern California Edison Company, November 1973).

Construction activity by earth-moving equipment would disrupt the soil and alter the topography at the plant site and surrounding areas. The probability of successfully seeding the soil on Dry Bench would be less than 3 years out of 10.

Water quality

The quality of ground and surface water at Dry Bench is characteristic of the Kaiparowits Plateau as described in Chapter II. Disposal of waste material such as fly ash and scrubber sludge would pose a threat to water quality.

Horse Flat

Air quality

Air quality is generally excellent. A complete description of air quality in the Kaiparowits Plateau impact area is presented in Chapter II. Horse Flat is within the plateau impact area.

The Horse Flat site is located on a gradually-sloping, smooth plateau with no prominent terrain features within 5 to 7 miles of the site (Southern California Edison Company, November 1973).

Because of the relatively high elevation and absence of large, local terrain features, the Horse Flat site is well exposed to winds and relatively good dispersion should occur at this site (Southern California Edison Company, November 1973). A stack height of about 700 feet would be required at this site. Potential impacts to air quality would be similar to those discussed for Fourmile Bench in Chapter III.

Biology

The stand of pinyon-juniper trees formerly occupying this site was removed and the site reseeded as a range improvement measure. The shrub species now growing on this site have more value as forage and browse than did the pinyon-juniper trees. Isolated stands of trees still occur on the site (Southern California Edison Company, November 1973). This site is of marginal value for deer winter use.

Construction of the generating facility would eliminate the existing vegetation from the plant site. Operation of the cooling towers would cause an additional loss of vegetation due to salt drift and salt accumulation in the soil. Loss of vegetation from the plant site and surrounding areas would reduce available food for livestock and deer.

Archaeology

A small rock shelter, with evidence of aboriginal occupation, was found on the Horse Flat site. It is probable that several other rock shelters showing evidence of occupation also occur on the site. The chance of an intact archaeological site of major importance occurring on the site is minimal, due to previous

clearing activities. However, surrounding undisturbed areas probably contain intact pine nut harvesting camps, and possibly winter villages (Southern California Edison Company, November 1973).

Construction of the generating facility would cause the loss of archaeological materials within and nearby the plant site. Destruction of this little - studied site would cause the loss of a nonrenewable resource. Further study and salvage operations would be necessary to mitigate archaeological losses.

Site geology/seismology

The Horse Flat site is relatively free from any major seismic activity. A thin layer of soil overlays sedimentary rock consisting of Kaiparowits Formation - sandstone with interbedded mudstone up to 10 feet thick (Southern California Edison Company, November 1973).

Construction activity by earth-moving equipment would disrupt the soil and alter the topography at the plant site and surrounding areas. The probability of successfully seeding the soil on Horse Flat would be 3 to 5 years out of 10.

Water quality

Water quality of ground and surface waters at Horse Flat is characteristic of the Kaiparowits Plateau as described in Chapter II. Disposal of waste materials such as fly ash and scrubber sludge would pose a threat to water quality.

<u>Summary and comparison of sites to the Fourmile Bench proposal</u>

Air quality

One of the major concerns regarding siting of a generating station in south-central Utah is the possible interaction with emissions from the Navajo plant and effects on visibility in scenic areas, particularly Grand Canyon. The degree of interaction and visibility impact is largely controlled by meteorological conditions at the site and the effects of topography on plume dispersion. Another

important parameter is the distance separating a generating station from particular points of interest. Separation distance is important, because both magnitude and frequency of occurrence of a given ambient air concentration or visibility impact will, in general, decrease with distance from the generating station. Finally, with respect to plume interaction, elevation differences between the proposed Kaiparowits station and the Navajo plant are important in determining the mechanism of plume transport--air drainage winds or synoptic winds.

Consultants for the companies have stated they do not anticipate any plume interaction between any of the alternate sites and the Navajo plant, with the exception of infrequent occasions at the Dry Bench site. This is based on considerations of both separation and elevation differences.

Distances of separation between the four sites and the Navajo plant, Page, Grand Canyon (North Rim), Bryce Canyon (Rainbow Point), Zion National Park, and Rainbow Bridge are summarized in Figure VIII-21.

FIGURE VIII-21

Distances in Miles of Alternate Site Power Plant Locations
From other Points of Interest in the Area

Points of Interest	Fourmile Bench (6,160 Feet Elevation)	John Henry Bench (5,000 Feet Elevation)	Horse Flat (5,900 Feet Elevation)	Dry Bench (5,200 Feet Elevation)
Navajo Power Plant	36	27	41	34
Page, Arizona	32	23	36	31
Grand Canyon National Park	76	70	75	79
Bryce Canyon National Park	32	38	24	41
Zion National Park	71	73	63	81
Rainbow Bridge National Monument	44	38	51	36

The Fourmile Bench site and the Horse Flat site are generally located farthest from points of interest and importance in this area.

Visibility

Another important aspect considered in the siting of a power plant in the Kaiparowits Plateau area is the visibility of the plant and related structures from scenic areas and other points of interest. Line of sight profiles to various points of interest from the four proposed alternate power plant sites are presented in Illustrations VIII-103 through VIII-108. The distances to important points of interest vary for each alternative. However, because of the large distances involved there are no important site specific differences in visibility.

Biology

Regardless of the site chosen for the power plant, impacts within the Kaiparowits Plateau impact area would not vary markedly from those already discussed in Chapter III. Site specific impacts would differ but there is insufficient data on each site proposal and access road routing to evaluate impacts in any degree of depth or detail. A less diverse populaton of wildlife containing practically no game animals would be impacted on Nipple Bench. On other alternate sites the impacted wildlife populations would be similar to those of Fourmile Bench. Hazard to aquatic habitat from plant emissions may be slightly more likely at Nipple Bench than the other sites farther from Lake Powell.

Archaeology

Base-line information regarding alternative sites is insufficient to evaluate site specific differences in impacts to any degree of depth or detail.

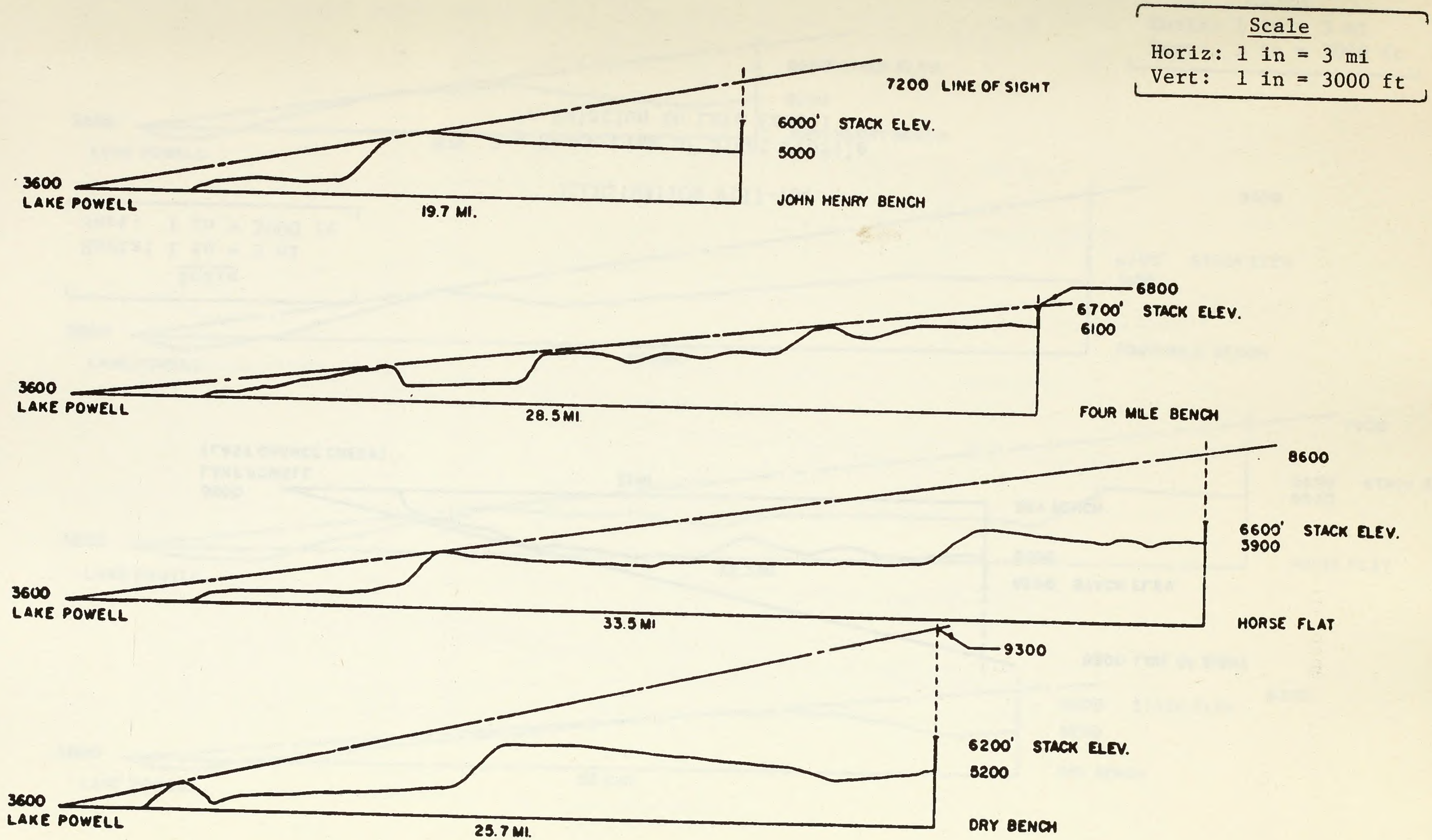
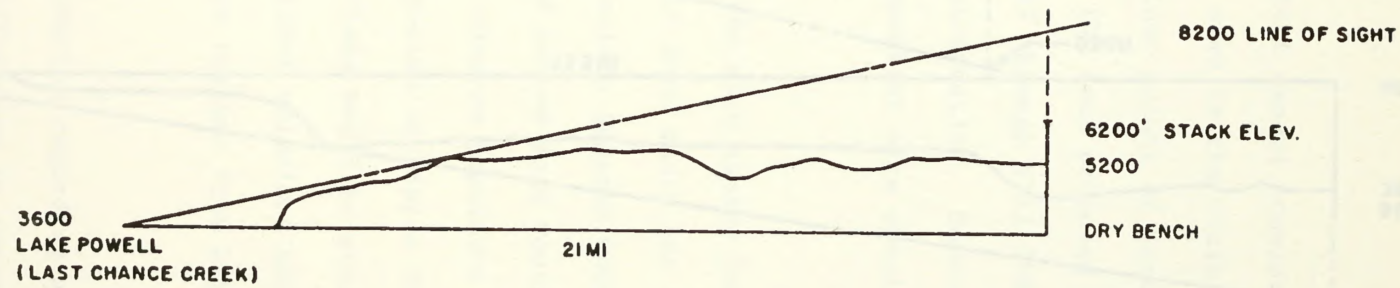


ILLUSTRATION VIII-103

Warm Creek Basin Line of Sight Profiles
in Relation to
John Henry Bench, Fourmile Bench, Horse Flat, and Dry Bench



Scale
Horiz: 1 in = 3 mi
Vert: 1 in = 3000 ft

ILLUSTRATION VIII-104

Dry Bench Line of Sight Profile
in Relation to Lake Powell

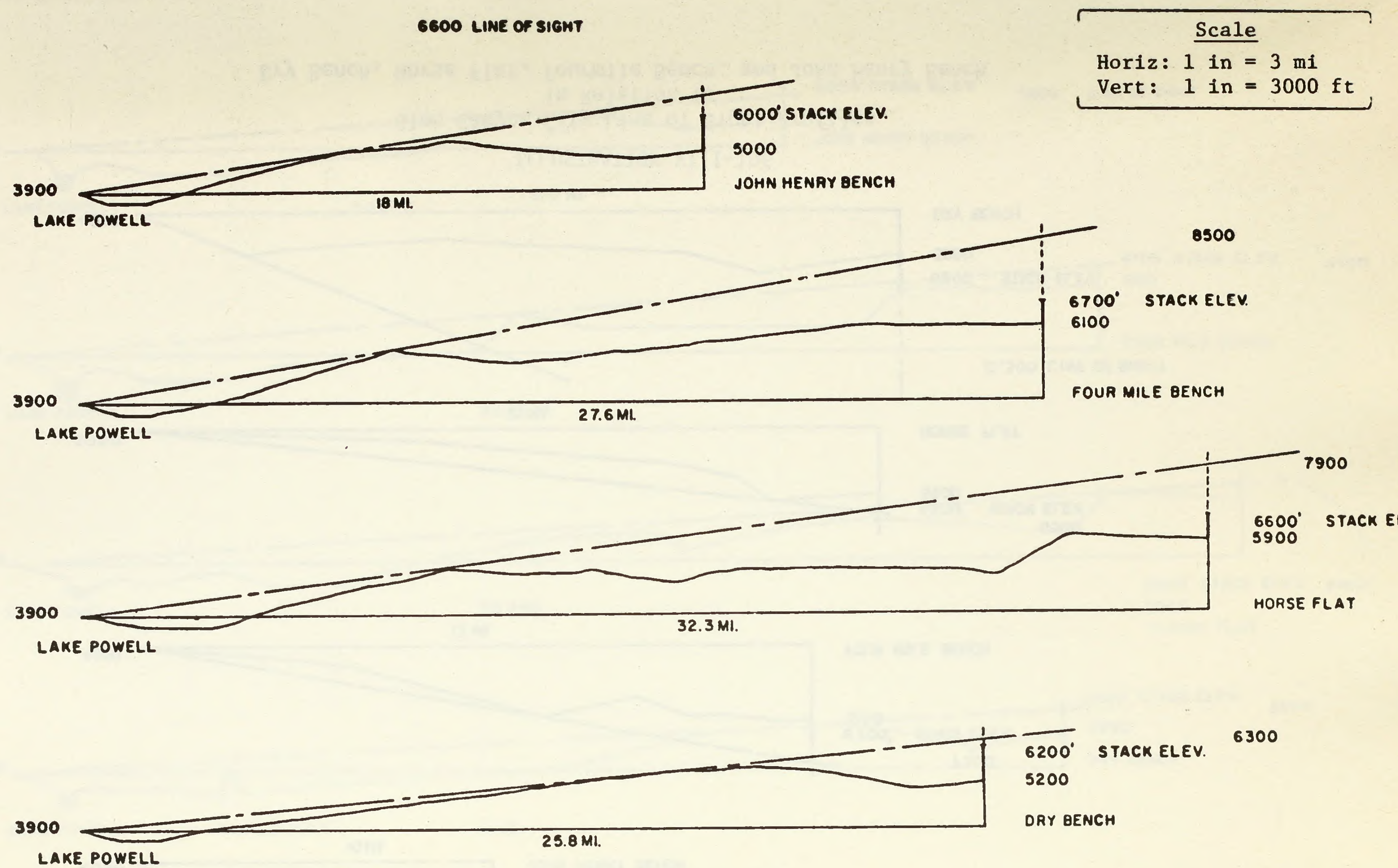


ILLUSTRATION VIII-105

Wahweap Line of Sight Profiles
in Relation to
John Henry Bench, Fourmile Bench, Horse Flat, and Dry Bench

Scale

Horiz: 1 in = 3 mi
Vert: 1 in = 3000 ft

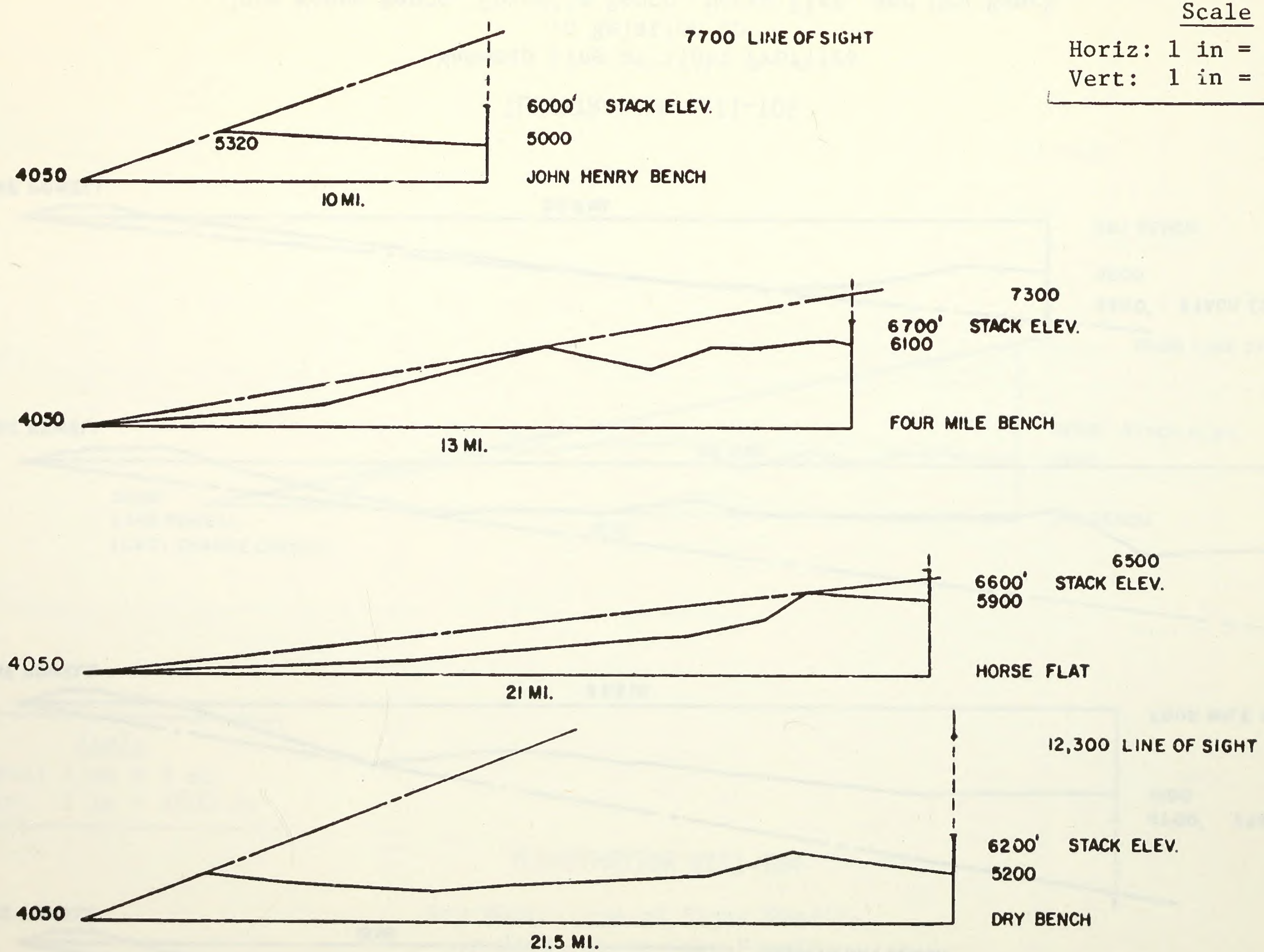


ILLUSTRATION VIII-106

Glen Canyon City Line of Sight Profiles
in Relation to
Dry Bench, Horse Flat, Fourmile Bench, and John Henry Bench

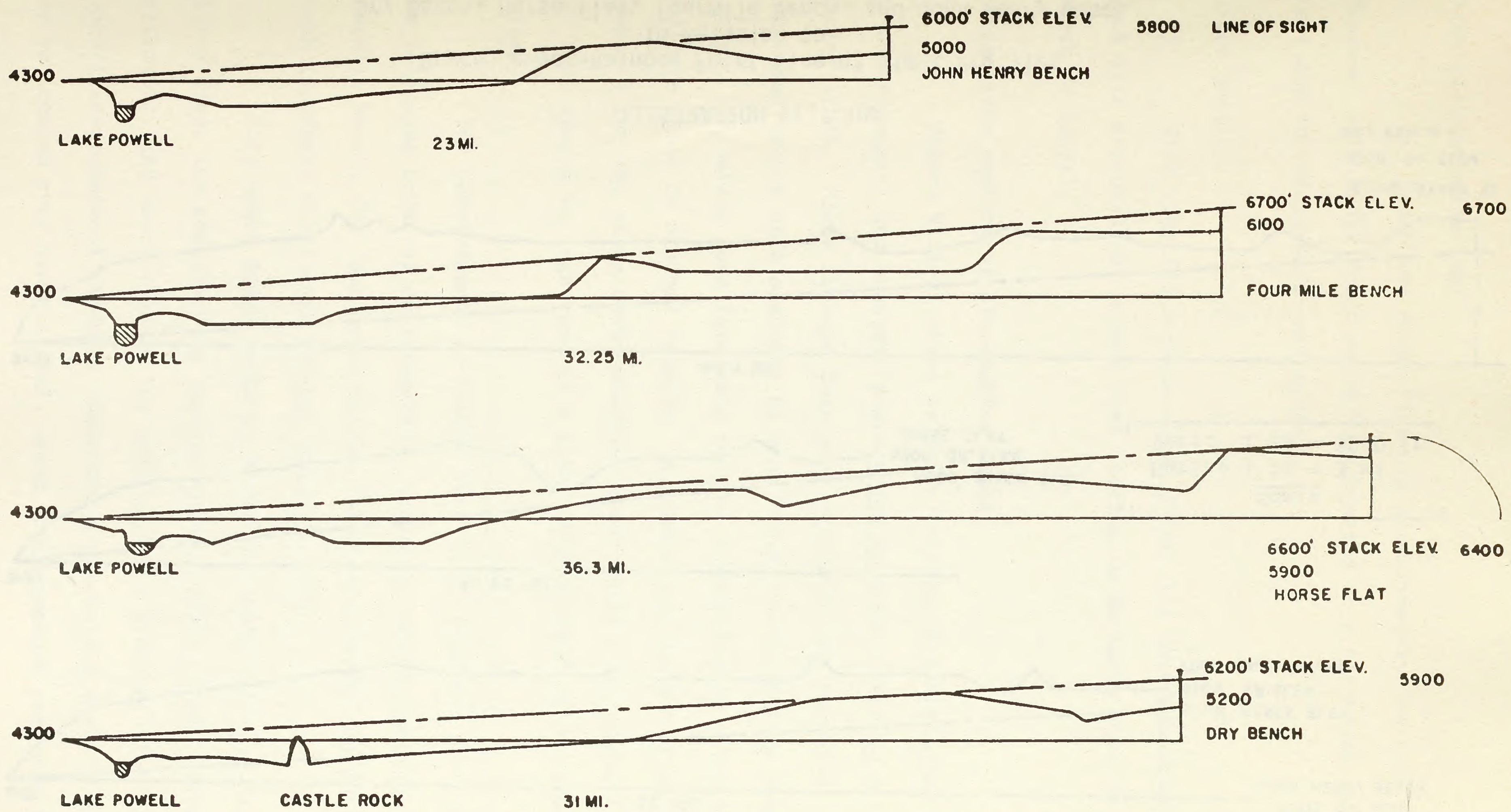


ILLUSTRATION VIII-107

Page Line of Sight Profiles
in Relation to
John Henry Bench, Fourmile Bench, Horse Flat, and Dry Bench

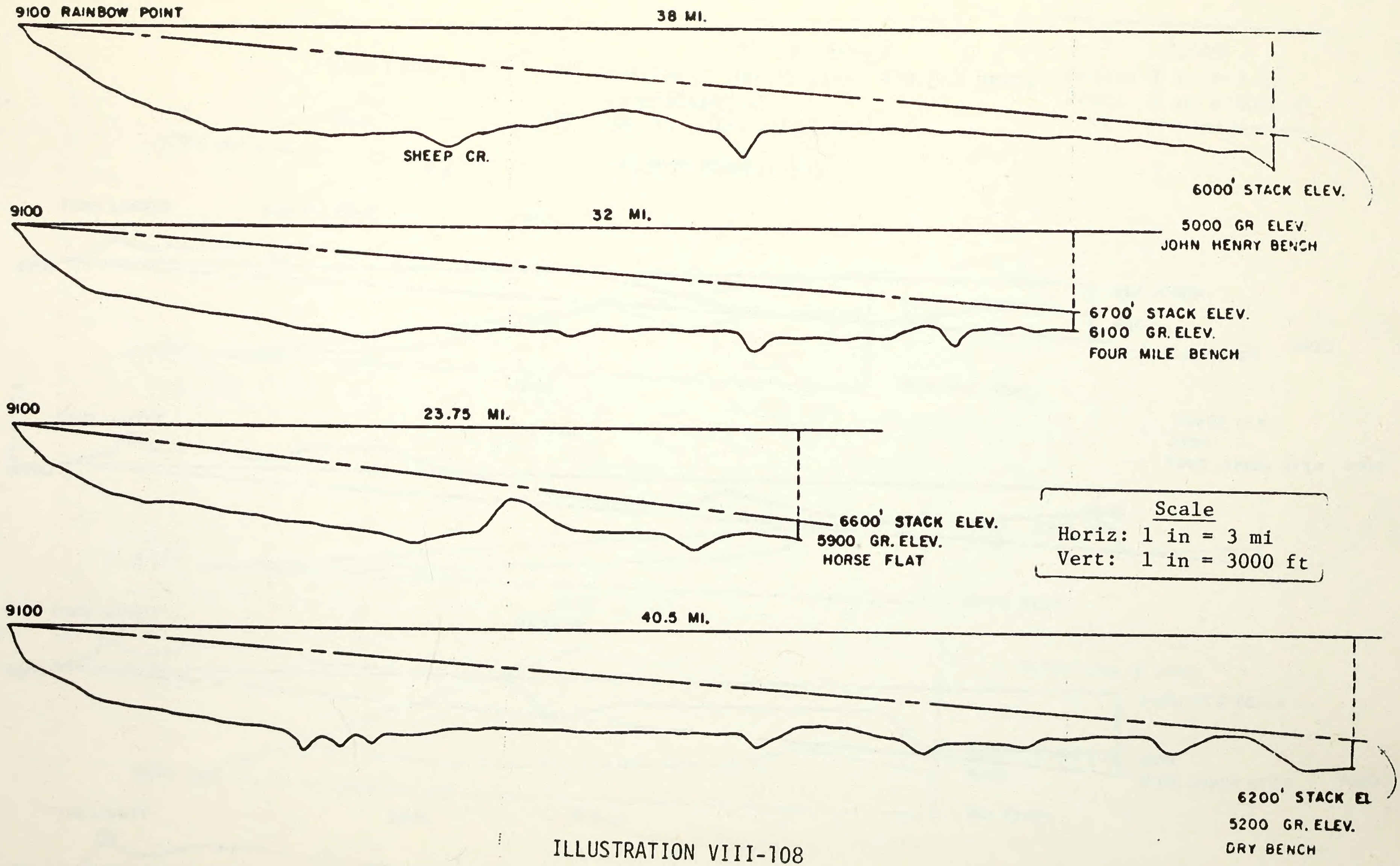


ILLUSTRATION VIII-108

Bryce Canyon-Rainbow Point Line of Sight Profiles
in Relation to
Dry Bench, Horse Flat, Fourmile Bench, and John Henry Bench

Site geology/seismology

Dry Bench and Horse Flat are approximately the same as Fourmile Bench. However, John Henry Bench could be subjected to a potential subsidence of 15 to 18 feet due to underground coal mining.

Water quality

Site specific impacts would differ but there is insufficient data on each site proposal and access road routing to evaluate impacts in any degree of depth or detail.

Comparative ranking of alternative sites

Figure VIII-22 shows relative ranking of alternative sites with respect to environmental and economic/engineering factors, based on the participants' siting study. Since factors that were evaluated are not equal or easily compared, weighting values were assigned to each factor to facilitate comparison. A low number, indicating more favorable ranking compared with other sites, does not indicate minor or minimal impacts. A generating station located at a site ranked number 1 for any given environmental factor could cause significant disturbances, but they should be less than if a plant were located at the other higher ranking sites.

The participants concluded from their findings that the sites would have the following order of environmental, economic, and engineering feasibility: (1) Fourmile Bench, (2) John Henry Bench, (3) Nipple Bench, (4) Horse Flat, (5) Dry Bench (Southern California Edison, November 1973).

John Henry Bench could be a suitable site since it is nearest the mining area, thereby allowing shorter service roads, some centralized surface facilities, and shorter water and coal delivery systems, with some reduction in overall environmental impacts. However, a generating station on John Henry Bench may be located over minable coal, which could prevent recovery or make mining

FIGURE VIII-22

Comparative Ranking of Alternative Sites in the Kaiparowits Plateau

Environmental factors	John Henry Bench	Dry Bench	Fourmile Bench	Horse Flat	Nipple Bench
Visibility of plant and plume	2[a]	2	1	2	3
Visibility of transmission structures	1	1	2	2	1
Plume dispersion	3	3	1	1	2
Plume interaction with Navajo plant	2	2	1	1	2
Biological	1	2	2	2	1
Archaeological and scenic	1	2	3	3	1
Construction effects	1	3	2	3	2
Noise attenuation	1	1	1	1	2
Economic/engineering					
Coal conveyance	1	2	3	4	2
Water conveyance	1	2	3	4	1
Transmission routing	1	3	2	3	1
Site access and adaptability	2	2	1	1	1
Availability of ash disposal sites	2	4	1	3	1

[a]Lower numbers indicate more favorable rank (less environmental impact, less cost and/or engineering difficulty). Higher numbers indicate less favorable rank (greater environmental impact, more cost and/or engineering difficulty). The same number for different sites indicates that there would be little difference between sites. Because different factors of differing importance are being ranked, the rank numbers are not additive for any site. (See text for evaluation of results.)

Adapted from Southern California Edison, Southern Utah Siting Study, November 9, 1973.

hazardous. The likelihood of air pollution also appears to be greater on John Henry Bench than at all other sites except Dry Bench.

Horse Flat is similar to Fourmile Bench with respect to potential environmental distrubance, but its location would require longer coal and water delivery systems, with resulting environmental impacts. Dry Bench would also require longer coal and water conveyance than any of the sites except Horse Flat. Dry Bench is generally less satisfactory because of relatively poor plume dispersion potential. In addition, transmission lines would have to be longer than at other sites.

These alternative plant sites would also have to be evaluated with respect to potential town sites. However, it should be emphasized that the coal mines would be located in the same place regardless of the plant site. And most permanent employees would work in the coal mines. Therefore, the relationship of the plant site to the new town is not of major significance.

A generating station at any alternate site except John Henry Bench would require re-routing the proposed access highway. Studies have not been made to determine the most feasible route for each site, but all sites would require a longer access highway than the proposed highway that could serve Fourmile Bench or Nipple Bench. Cumulative impacts and cost would, therefore, be greater.

Other possible alternate bench top sites, which apparently were not considered by the participants, include Jack Riggs Bench, Window Sash Bench, and Paradise Bench. None of these sites appear to have significant advantages that would reduce environmental disturbance if they were selected for location of a generating station. Jack Riggs Bench is about 12 miles northwest of Nipple Bench, and has a surface elevation of about 5,400 feet. Higher terrain to the north may inhibit air dispersal, and local terrain would make access difficult and expensive. Coal and water delivery systems would be longer than for most

other sites, and would have to cross or avoid several canyons, resulting in additional aesthetic and environmental impacts.

Window Sash Bench is about 5 miles north-northeast of Dry Bench. Average elevation is about 6,000 feet. There is higher terrain immediately to the west. Fiftymile Mountain is about 11 miles to the east. Although air dispersal characteristics may be favorable, the site is on a coal lease and would be about 5 miles from the mining area.

Paradise Bench, about 6 miles northeast of Fourmile Bench, averages about 6,000 feet in elevation. Air dispersal characteristics should be favorable because of absence of nearby higher terrain, but this site is near coal leases and may be over minable coal. Coal and water conveyance systems would have to cross canyons or be routed along canyons of Last Chance drainage. Access to Window Sash and Paradise benches would require a longer highway than the proposed route, and additional cuts, fills, and bridges to cross intervening canyons.

ALTERNATE SITES INSIDE OF UTAH BUT OUTSIDE OF THE KAIPAROWITS PLATEAU

Should a 3,000 megawatt (MW) generating station be constructed within the Colorado River Drainage - within Utah but outside of the Kaiparowits Plateau - increased costs would be incurred due to the long distances involved in shipping coal and materials from the Kaiparowits Plateau, and the increased distances involved in construction of transmission lines. In addition to the increased costs, there would also be adverse impacts to aesthetics by the placement of transmission lines and railroads or slurry pipe lines near or adjacent to Glen Canyon National Recreation Area, Capitol Reef National Park, and Dixie and Fishlake National Forests.

Also, there would be disturbance of large acreages of fragile soils of Cretaceous origin (members of the Mancos Shale Formation) that are not suitable for reseeding (after disturbance) and which would result in increased dust particles in the atmosphere and sediment deposition into drainage channels.

Should a 3,000 MW generating station be constructed in the western portion of the state of Utah, the aesthetics of Dixie and Fishlake National Forests, as well as Bryce and Zion National Parks, would be adversely affected due to the placement of water pipe lines and railroads or slurry pipe lines. In addition, legal issues would arise due to the transbasin diversion of water. This alternative would also increase the costs of transporting water coal.

Because the above alternatives would be economically unfeasible, would cause substantial environmental consequences, and would be inconsistent with legal and contractual requirements, such alternatives do not appear to be reasonably viable.

ALTERNATE GENERATING STATION SITES OUTSIDE UTAH

Consideration of locating a large generating station either in or outside of Utah must include (1) probable unavoidable environmental impacts, (2) likelihood of meeting state and federal air and water quality standards, (3) physical and legal availability of water, (4) availability of fuel, and (5) acceptance of the project by local populace. These considerations are not in any particular order of importance; they vary considerably with location.

California

The probability of a coal-fired generating plant meeting the stringent air quality standards of California Air Pollution Control Districts is low, even with present emission control technology. The California Resources Agency report, Energy Dilemma, California's 20-Year Power Plant Siting Plan (Sacramento, June 1973), states: "The optimum locations for coal-fired power plants would be those within reasonable reach of the coal fields and the service area and in an area where state and federal air quality standards are not already exceeded . . . . Because the coal fields all lie outside California, the most favorable power plant sites are located in Arizona, northern New Mexico, southern Nevada, and southern Utah. The alternative procedure is transporting a slurry of ground coal and water by pipe line as fuel for power plants in southern California. This, however, would not be acceptable due to air quality considerations. This situation could change, if and when air quality standards are attained in the Southeast Desert Air Basin" (p. 11). "One 1,250 MW power plant has been proposed for the Southeast Desert by 1991" (p. 41). The Rand study (Ball, et al., 1972, p. 84) notes: "The regulations on NO_x, however, impose limits for large power plants that are beyond the capabilities of current technology if the plant has a power output much greater than 300 MW."

The California Air Resources Board has stated, "Location of the facilities in California would be virtually impossible. Even if the long transport of

coal from the mines to the west coast could be justified, the severe air pollution problems in Southern California would eliminate all coastal sites. The adjacent inland areas are all critically short of water which would have to be transported long distances. Those areas of the state with more abundant water are mostly prime agricultural land or recreation areas, neither of which could readily accommodate a major coal burning power plant.

"The probability of a coal-fired generating station meeting the stringent air quality standards of the California air pollution control districts is low, even with the best emission control technology . . . . " (See Appendix VIII-2.)

A future alternative could exist in ten 300-MW coal-fired power plants equipped with the latest pollution control equipment and scattered about the state in such fashion that the emissions from one would not reinforce the emissions from any other; however, the use of such an alternative would (1) substantially increase the cost of construction and operation to an uneconomic degree; (2) multiply siting problems ten-fold, including multiplying problems with local opposition, thus materially lengthening the time required for construction; (3) reduce the companies' safe operating margins because of the delay; and (4) preclude the use of the sites and any air quality margins for other purposes. Since there are no alternative sites available in California under present conditions of air quality, possible sites have not been selected; therefore, other beneficial and adverse environmental impacts of sites in California have not been evaluated.

Nevada and Arizona

An alternative to the proposed project, which might meet the participants' expressed needs, would be to expand generating capacity of Mohave and Navajo plants in Nevada and Arizona, using coal either from Kaiparowits Plateau or Black

Mesa, Arizona. The following is a discussion of considerations involved in such alternatives.

Mohave generating station is in southern Clark County, Nevada, west of the Colorado River, on a 2,500 acre site in Township 32 South, Range 66 East, Mount Diablo Base and Meridian. The site is at an elevation of 700 feet above mean sea level in Mohave Valley, which is bounded on the east by mountain ranges that reach elevations of over 5,000 feet.

The site includes several broad, flat washes that slope gently toward the Colorado River. The valley floor at the site is sand and gravel. Evidence of faulting and recent earthquakes within 50 miles of the site indicate that likelihood of earthquakes is low. Creosote bush is dominant at the site. Endangered species are not in evidence, but the desert tortoise, a protected species, is found. Archaeological surveys, consisting of reconnaisance of the area in the vicinity of the generating station have located six archaeological sites.

Two or four additional 750 MW units would increase Mohave station generating capacity to 3,000 or 4,500 MW. According to the participants, base plant facilities for a 4,500 MW plant would be the same as proposed for Kaiparowits. The facility would be designed to meet all applicable air quality requirements.

If the Mohave plant capacity were increased by 3,000 MW, an expansion of the Navajo station might not be necessary. An additional 3,000 MW of generation at the Mohave generating site would involve two Mohave-Devers 500 kV lines and two Devers-Serrano 500 kV lines. The Arizona participants' share could be transmitted over the existing 500 kV system to the Navajo and Moenkopi substations. From Moenkopi, however, a 500 kV line to the Liberty substation, and a Liberty to Westwing 500 kV line would be needed. No new transmission requirements would be necessary for the San Diego Gas and Electric Company's share of the 3,000 MW.

Coal is presently delivered to the Mohave plant through a 275-mile slurry pipe line from Black Mesa, Arizona. Coal for an expanded plant could be transported by rail. According to participants, the Mohave station could be serviced by the Atchison, Topeka and Santa Fe Railroad by building a rail spur approximately 230 miles long from the Kaiparowits coal field to Flagstaff, Arizona, to connect with the ATSF rail line and a 23-mile spur from the rail line junction in Piute Valley, California, to the Mohave plant site.

Additional alternative coal delivery systems would be (1) a rail line more than 200 miles long from Kaiparowits Plateau to near St. George, Utah, and north to the Union Pacific spur at Cedar City, or (2) an additional or enlarged slurry pipe line from Black Mesa, Arizona, or (3) a 350-mile Kaiparowits to Mohave slurry line.

The Navajo generating station is 4 miles east of Page, Arizona. The site is on a low bench, 3! miles from Lake Powell, at an elevation of about 4,360 feet above mean sea level. Higher terrain is to the south. Blackbrush is the predominant vegetation in the area of the generating station. Facilities occupy about 2,200 acres, and present generating capacity is 2,250 MW. An additional 750 MW unit would increase the total generating capacity to 3,000 MW.

The transmission system serves the Phoenix area via the Moenkopi substation and Los Angeles via the McCullough substation in Nevada. Coal is supplied from the Black Mesa mine by an 80-mile railroad.

The Black Mesa mine is a strip-mining operation on 64,858 acres of tribal lands leased by Peabody Coal Company from the Navajo and Hopi. The mesa is a moderately dissected highland about 4,000 to 7,000 feet above mean sea level, and is covered by mixed grassland, sagebrush grassland, and pinyon-juniper woodland, depending on elevation. The mine is expected to supply 5 million tons of coal annually to the Mohave plant and 8 million tons to the Navajo plant by

1976, when all units should be completed and in full operation. Peabody expects to mine an average of 400 acres each year, and to restore and revegetate the mined area.

Probable unavoidable impacts resulting from expansion of Mohave, Navajo, and related facilities would include air quality, spreading and intensification of impacts at each site, and additional impacts resulting from new railroads or slurry pipe lines.

Both Mohave and Navajo plants are presently being extensively studied to determine ground-level concentrations of sulfur dioxide, nitrogen oxide and particulate matter from present plant operation. Results of these studies would provide a basis for assessment of additional impacts on air quality as a result of an increase in the generating capacity of these two plants.

Increasing the combined generating capacity of Mohave and Navajo stations from the presently designed total of almost 3,760 MW to more than 6,000 MW would almost double the present requirement for coal, to more than 20 million tons a year. If additional coal were supplied from Kaiparowits Plateau, environmental impacts would be similar to those already discussed in this statement for the proposed project, except for disturbances directly attributable to the proposed generating station and transmission system. However, a railroad or slurry line would result in several additional impacts. Impacts due to a railroad would depend on whether the route would be from Kaiparowits to Flagstaff or to Cedar City. Specific impacts cannot be identified until actual railroad or slurry line routes are identified.

The participants suggestion of a rail line from Kaiparowits to Flagstaff raises questions as to the technical means of tranporting coal across the Colorado River near the Kaiparowits Plateau, and whether rights-of-way for such a crossing and for a route through lands administered by the National Park Service and the

Navajo Tribal Council could be obtained. Therefore, a more feasible route for either rail or pipe line might be to Cedar City, perhaps roughly parallel with the proposed highway via Nipple Creek, U.S. 89 towards Kanab, the highway from Fredonia, Arizona, to Hurricane, Utah (Arizona 389 and Utah 59), and Interstate 15 to Cedar City.

Impacts due to a railroad to Cedar City would include: more than 200 miles of right-of-way disturbance, with cuts, fills, culverts, eradication of vegetation, and disruption of present land uses along the route; noise, air pollution, and risk of accidents; and irretrievable loss of locomotive fuel. The railroad could also be used for passenger service and freight to the region (more inexpensively than current automobile and truck haulage), and it might stimulate growth of industry.

The proposed railroad from Kaiparowits to Cedar City, Utah, via St. George, Utah would disturb approximately 1,300 acres more than the power plant proposal on Fourmile Bench. Also there would be an adverse impact to scenic areas such as Zion National Park.

Impacts due to a slurry line about 350 miles long would occur mostly during construction, when trenching and staging would eradicate vegetation and scar the earth. If rehabilitation of disturbed areas were successful, however, these disturbances would generally be mitigated. Pumping stations and points where the line would be above ground would remain visible. Also, the slurry would require approximately 41,290 acre-feet less water than the power plant. However, 41,400 acre-feet of additional water would be needed at Mohave if its capacity was expanded to 3,000 MW.

Expansion of the Black Mesa coal mine would disturb considerably more surface area than is likely with the present project. It would cause disturbance during construction of an additional or larger slurry pipe line, and displace more

Indian families. Expansion to a 20 to 24 million ton per year mine would require additional expenditure of material, but it would increase capital and employment in northeastern Arizona.

Increasing the generating capacity of the Mohave plant by 1,500 MW to 3,000 MW and the capacity of the Navajo plant by 750 MW could require an additional commitment of 41,000 to 72,650 acre-feet of water. This assumes 33,750 to 56,250 acre-feet used in wet cooling towers at the generating stations, 2,400 to 6,500 acre-feet in a slurry pipe line from Black Mesa or Kaiparowits, 5,000 acre-feet for municipal use, and 5,000 acre-feet for underground mining needs in the Kaiparowits Plateau. Adequate amounts of water to supply these needs are physically available from the Colorado River and, for slurry and municipal purposes, from underground storage. However, several legal constraints would have to be met to permit actual use of the water. These can be identified with the three states that could be involved - Utah, Nevada, and Arizona.

The participants' rights and water service agreements with the State of Utah and the Department of the Interior specify that up to 120,000 acre-feet of water from the Colorado River is to be used only for steam-electric generation in Kane County, Utah, utilizing coal mined in the Kaiparowits Plateau. If the project is abandoned, rights to use the water would revert to Utah. Under these agreements, therefore, water for mining, slurry transport, and municipal use would not be available if the generating station were located outside of Utah. These alternate uses would require renegotiation to obtain new agreements. Use of Utah's allocation of Colorado River water for cooling a generating station in another state could require an Act of Congress, including possible modification of the Colorado River Compact which governs allocation of water. It is the present policy of the State of Utah not to allow water rights for diversion and use of the waters of the State outside of Utah, except under reciprocal agreements

under which the water would be used on lands that span the state line (Utah Division of Water Rights, by telephone, December 16, 1975). Use of Utah's waters outside the state probably would require a change in the State Constitution.

The State of Nevada is allotted 300,000 acre-feet of water annually from the Colorado River. This amount may be inadequate for the immediate future requirements of southern Nevada. The Colorado River Commission of Nevada has contracted with the Southern California Edison Company for delivery of 30,000 acre-feet of water annually from Lake Mead. This water, which will be used by the present Mohave power plant, is to be made available until July 1, 2006. No provision is made to extend the contract beyond that date. An alternative source of cooling water for additional generation in southern Nevada would be reclaimed waste water from the City of Las Vegas, but this water is planned for use by the proposed 2,000 MW Harry Allen Project scheduled for commercial operation during 1979-1982.

Arizona's Colorado River water Upper Basin allocation, which would affect the Page area, is 50,000 acre-feet per year. The water service contract to permit use of Colorado River water for the Navajo generating station permits withdrawal of up to 40,000 acre-feet per year. The present Navajo generating station is expected to use an average of 34,000 acre-feet annually. The balance of 6,000 acre-feet is insufficient for an added 750 MW unit. Assuming that a wet cooling tower would be used, an additional unit would require about 11,250 acre-feet, exceeding the contract limits by about 5,250 acre-feet.

Water supply for the Black Mesa-Mohave slurry system is obtained from deep wells, which are partly lined in an effort to prevent draining water from the shallower perched aquifers penetrated by Navajo and Hopi wells. Although it is estimated that there is an abundant supply of deep subsurface water (Bureau of Reclamation, 1972), the possibility of interfering with present and future Indian water needs exists.

An appropriate selection of methods could mitigate some of these problems. For example, a combination of wet/dry cooling towers for additional generating units at Mohave and Navajo would reduce the water requirement, possibly to a level where cooling water needs could be met legally and physically. A railroad rather than a slurry line from Kaiparowits or Black Mesa would eliminate the need for slurry water. Municipal water requirements, estimated at a total of up to 5,000 acre-feet annually, would probably not be required entirely at one location. The increase in requirements might be relatively small at Page and Black Mesa, for example, and might be very small in the Kaiparowits area if coal was not supplied from Utah.

Sufficient coal is present in the Kaiparowits Plateau and under lease by the participants to supply the needs for alternative generating station locations. An adequate supply of coal is known to exist and is under lease at Black Mesa to supply present generating station needs, but it is not known if there are sufficient reserves of minable coal to supply expanded generating stations. Such possible reserves are not presently under lease.

Attitudes of local residents most likely to be affected by these alternatives are unknown at this time. In particular, attitudes of the Navajo and Hopi would be significant if the alternatives included expansion of the Navajo generating station and the Black Mesa mine. Negotiations would be necessary to obtain permits for exploration for additional coal, for additional coal leases, rights-of-way, and water rights, and possibly for leasing more land.

If no coal were to be supplied from Utah, alternatives of meeting the participants' estimated needs by expanding the Mohave and Navajo generating stations and using coal from Black Mesa would eliminate impacts indicated in this statement as likely to occur in Utah. Impacts would be confined largely to locations already identified for steam-electric generation, coal mining, and

transmission of electricity, coal, and water. Generating sites would be closer to load centers, reducing some environmental disturbance and use of material for transmission system construction. Much of the impact would be on Navajo and Hopi Tribal lands. Although this would include increased employment and income, it would also involve displacement of people, environmental and cultural disturbance, and long-term and irretrievable commitments of resources. Other impacts would occur along the coal conveyance route, but would vary according to route and whether transport was by rail or slurry pipe line. There would be additional impacts in the vicinity of the Mohave and Navajo generating stations, particularly with respect to air and water quality and socioeconomic conditions.

Feasibility of these alternatives would depend on such factors as: environmental impacts that could result, compared to those that could occur with the proposed Kaiparowits project; availability of water and of coal at Black Mesa; whether additional coal leases could be obtained at Black Mesa; and technological and economic considerations. Economic considerations including efficiency of various alternatives, which involve relative amounts of usable energy obtained from resources, are discussed in the Federal Energy Administration report (Appendix I-1 of this statement).

ALTERNATE LIMESTONE QUARRY SITES

The proposed quarry site selection was based on consideration by the participants of many factors: limestone quantity and quality, transportation distance, existing highways, environmental impact resulting from quarrying, attitude of limestone beds and the amount of overburden. The limestone quality could not exceed 4 percent silica when used for rock dusting. This was established by the Mining Enforcement Safety Administration to avoid the potential problem of silicosis of the lungs of miners.

Several alternative sites were investigated (see Illustration VIII-109). The following briefly summarizes considerations and main field investigations involved in alternate sites.

Buckskin Mountain

This feature is produced by outcroppings of the Kaibab formation. This site was investigated because of its proximity to Kaiparowits Plateau. However, initial geologic reconnaissance revealed that the silica content was too high to be suitable for rock dusting, and that the silica varied widely over lateral dimensions of the formation. It is estimated that a large surface exploration program (access roads and drill sites) would be required to prospect for a low-silica zone.

Highway 89 near Mount Carmel Junction

Preliminary analysis showed that limestone beds existed with a suitable silica content. Further investigations concluded that the low-silica limestone material was contained in a 15-foot bed which forms the cap rock of mesas immediately adjacent to U.S. Highway 89. However, haulage distances to the plant site would be approximately 115 miles, which is 53 miles greater than the proposal. Energy consumption and emissions from hauling would be 3.4 times greater

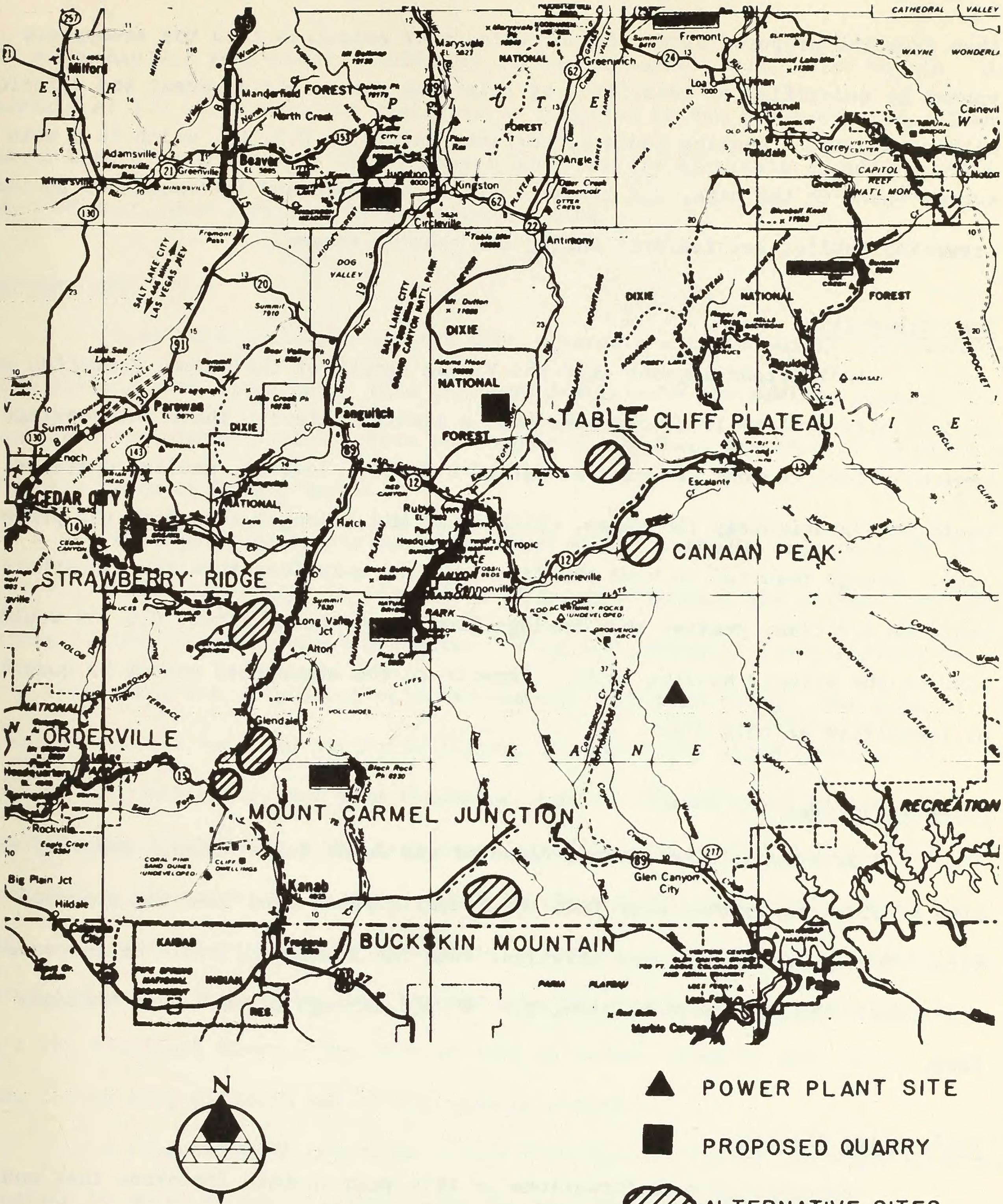


ILLUSTRATION VIII-109

Alternative Limestone Sites

than from the proposed site. Actual effects of emissions into the atmosphere cannot be quantified or identified at this time due to air movement and dilution within the area. Hauling would be confined mainly to U.S. 89, which is a main access route in the area, and trucks could be a hazard and inconvenience to the traveling public, particularly during the tourist season.

Near Orderville

Indications suggest that the Virgin member of the Carmel Formation may include high-quality limestone beds over a limited extent. These outcroppings basically form caprock structures east of U.S. 89. However, hauling distance would be approximately 120 miles, which is 58 miles longer than from the proposed site. Energy required to haul the limestone and emissions into the atmosphere would be 3.7 times greater than haulage from the proposed site. U.S. 89 would also be the primary hauling route. Impacts to the atmosphere cannot be quantified or identified at this time.

Strawberry Ridge

This is the same strata found at the Johns Valley site. However, this site is 35 miles further away from the Fourmile Bench area than the proposed site. Energy consumption and emissions into the atmosphere would be increased 2.5 times. Hauling would be along U.S. 89 and through Bryce Canyon National Park.

Table Cliff Plateau

Outcropping rock formations on this mesa contain limestone that would be acceptable for rock dusting material. This is the same strata as that at the Johns Valley site. Ten miles of all-weather road to the mesa top would have to be constructed. Clearing 300 acres of heavily-timbered area would result from quarrying this site. Severe winter conditions could double the energy requirements

to allow haulage year-round. Emissions to the atmosphere would also double. An additional 120 acres would be disturbed as compared to the proposed site. This would result in an adverse visual impact and possibly eliminate an additional 6 head of deer, when compared to the proposed site.

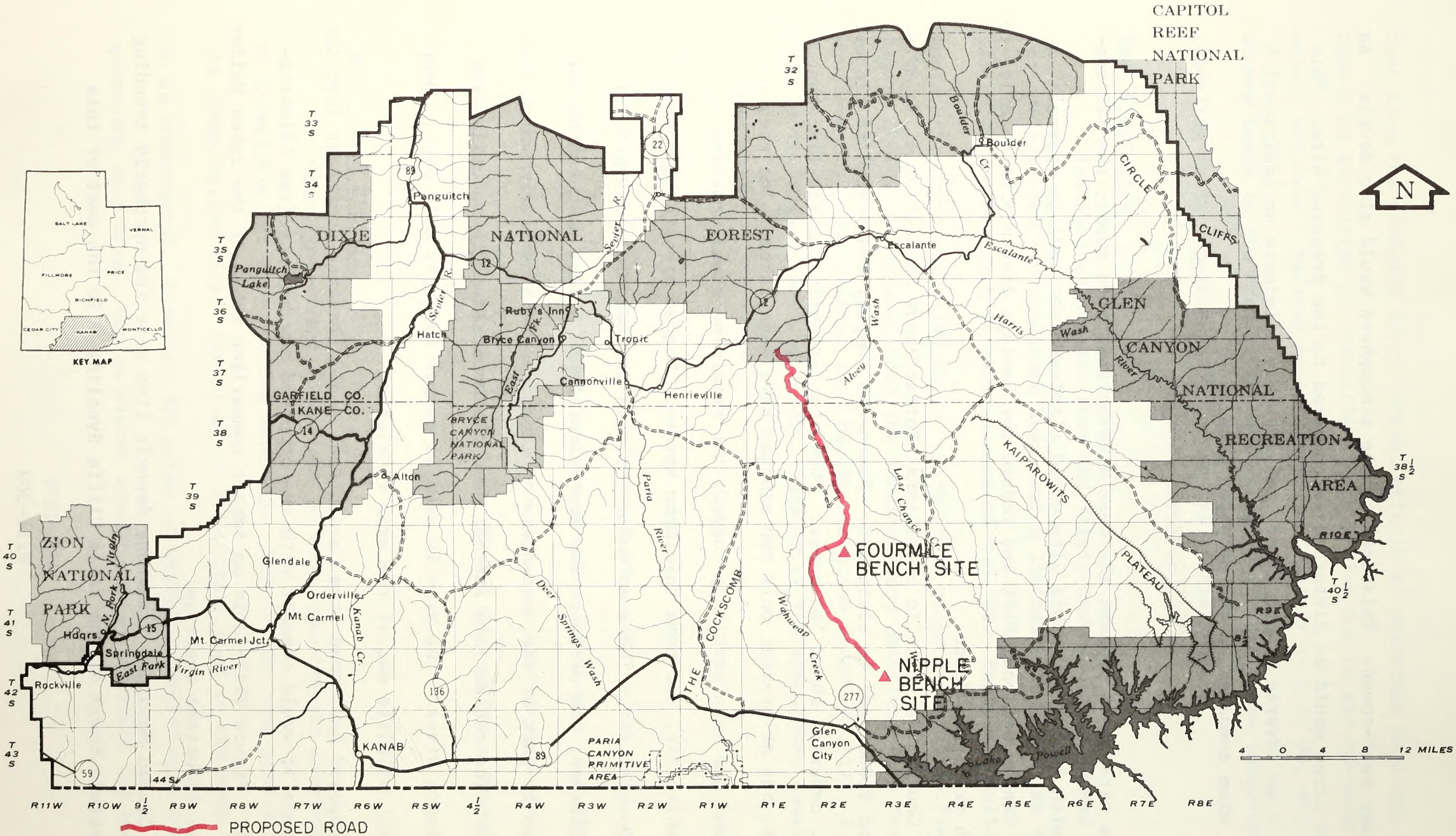
Canaan Peak

This site would present the best alternate site to supply the Kaiparowits project with limestone. This site would eliminate the haulage segment through Bryce Canyon National Park and reduce the haulage distance by 40 miles to Fourmile Bench or Nipple Bench.

The Canaan Peak site is on National Forest lands in Section 4, T. 37 S., R. 1 E., around 9,000 feet in elevation. Resources Company has staked 28 placer mining claims, covering about 560 acres. They are currently testing limestone from this site, but at present only two samples have been taken. The area is tree-covered and has been partially logged; the remaining stand consists of Douglas fir, white fir, and some Engelmann spruce. Logged areas have been planted with Douglas fir. The area under claim is included in the Upper Valley East cattle allotment and accounts for approximately 30 animal unit months per year. The area is part of the headwaters of Canaan and Willow creeks which flow intermittently. The creeks join farther down the mountain and eventually flow into the Escalante River. The area is used as summer range by mule deer. Deep snow forces most wildlife out of the area in winter.

A proposed haul road from Canaan Peak would traverse southeast down the mountain to where it would connect with the proposed new highway (see Illustration VIII-110). Figure VIII-23 is an impact comparison table of the Johns Valley and Canaan Peak limestone quarries.

The Canaan Mountain limestone deposit lies near the northerly trending axis of a structure known as the Table Cliffs Syncline. To the east of this



KANAB DISTRICT
1974
UTAH

ILLUSTRATION VIII-110

Proposed Haulage Route - Canaan Peak Alternate Quarry Site to Fourmile Bench and Nipple Bench

FIGURE VIII-23

Impact Comparison of Johns Valley and Canaan Peak Limestone Quarry Sites

	Johns Valley	Canaan Peak	Evaluation
Location	T. 34 S., R. 3 W. N.F. and State Lands	T. 37 S., R. 1 E. N.F. lands	
Approx. acreage involved in the quarry facilities	240 acres	240 acres	
Approx. elevation (ft. above sea level)	7,800	9,200	
Ann. precipitation	12-16 inches	18-22 inches	
Av temp (Jan)	19^{o} F	14^{o}-35^{o} F	
Av temp (Jul)	62^{o} F	45^{o}-78^{o} F	
Dominant vegetation type	Pinyon, juniper minor ponderosa, bristlecone pine	Douglas fir, White fir, Engelmann spruce	
Soils	Limestone derived loamy clays and clays	Limestone derived loamy clays and clays	
Topography and Geology	Limestone ridge	Dissected limestone plateau	
Existing transportation routes to Fourmile Plant site	15 miles paved (Highway 12) 47 miles graded/ graveled	4 miles no access 21 miles unimproved road	
Approx. Distance			
To Fourmile To Nipple	62 miles 80 miles	25 miles 40 miles	Canaan Peak site closer to plant site.
New road construction needed:			
To Fourmile To Nipple	None None	4 miles 19 miles	

(continued)

	Johns Valley	Canaan Peak	Evaluation
Road upgrading needed:			
To Fourmile To Nipple	5 miles 5 miles	21 miles 36 miles	
Surface Disturbance during construction	240 acres	390 acres	
Quantity and Quality of limestone	Adequate	Needs further testing	
Anticipated Environmental Impacts:			
Air Quality	Dust during blasting loading, truck movement, etc., truck emissions.	Dust during blasting, loading, truck movement, etc., truck emissions.	Less haulage distance from Canaan Peak, therefore less engine emissions, less movement along roads.
Soils	Disturbance by quarry and facilities	Disturbance by quarry and facilities. More disturbance by new road construction.	More disturbance by Canaan site due to new road construction.
Water Resources	Water well 2,000 gal/day	2,000 gal/day Source could be well or small reservoir.	
Vegetation	Loss of 240 acres	Loss of 345 acres	Pinyon-juniper remova at Johns Valley. Fir and Canaan Peak.
Wildlife	Deer, elk, prairie dog, sage grouse in area	Deer	Less wildlife variety at Canaan site - Displacement of wildlife both sites and added hunting pressur
Ecological interrelationship	Displacement of cattle, wildlife, reduced forage, added hunting pressure.	Displacement, reduced forage, added hunting pressure.	

(continued)

FIGURE VIII-23 (concluded)

	Johns Valley	Canaan Peak	Evaluation
Paleo., Arch., History	Arch. sites have been inventoried and preserved	No inventory at this time	
Recreational Resources	Better access into area will be gained for hunters. Added hunting pressure. Quarry can be hidden from major view.	Better access into area will be gained for hunters. Added pressure. Area has good recreational potential (camping, etc.). Road scars along new access. Quarry can be hidden from major view.	Canaan site would involve road scars. Canaan site has better potential for recreational use (camping, etc.) because of forest.
Land Uses:			
Livestock	64 AUMs affected	50 AUMs affected	More grazing on Johns site
Recreation	Increased access into area for recreational use. Trucks travel through Bryce Canyon N.P. and tourist road.	Increased access into area for recreational use. Little impact on tourist use.	Canaan Peak site would have less affect on tourist traffic into - out of Bryce N.P.
Mineral development	No other mineral development in area	No other mineral development in area	
Wood products	Not logged, potential low. 50,000 bd. ft. ponderosa pine would be cut. Fence posts, firewood affected.	Area logged and replanted in late 1960's. Potential for firewood, posts, Christmas trees.	Canaan site has high potential for wood products which would be lost.
Agriculture	Small agricultural use nearby. Use water from spring near site.	No agriculture	
Transportation facilities	Existing roads including paved highway (U-12)	Existing roads and new road construction	Need new road construction for Canaan
	Limestone trucks would travel along major highway through part of Bryce Canyon N.P. and through two small towns (Tropic, Cannonville) along with logging trucks, oil trucks.	No major traveled roads would be traversed, no towns encountered, site would avoid Bryce Canyon.	Canaan site haulage would involve less exposure to accidents traffic problems, would not be offensive to tourist traffic in Bryce Canyon area.

structure are the upward warps of the Upper Valley monocline and Upper Valley anticline. To the west, the formations also warp upward towards the Johns Valley anticline. Several faults of relatively small displacement and extent are probably present in the area, but no major faults have been mapped near the limestone deposit.

The limestone is within the Wasatch (Claron) formation based largely on color, this formation has been divided into three members: a lower pink limestone, a middle white limestone, and an upper varigated member of sandstone, siltstone, mudstone and limestone. The middle white limestone member is the source of the best quality limestone. The total thickness of the Wasatch formation may be as much as 1,600 feet. In the Table Cliff Plateau northwest of Canaan Mountain, the Wasatch reaches thicknesses of: upper sandstone member, 250-300 feet; middle white limestone member, 500-550 feet; lower pink limestone member, 800-850 feet.

The proposed limestone quarry is in the north-central portion of the Kaiparowits Plateau coal field. However, none of the subject lands are encumbered with coal leases or permits. Coal undoubtedly underlies the limestone site, but it would be at depths of over 3,000 feet. The quarry site is also only about 3 miles west of the Upper Valley oil field but there is no legal conflict with oil and gas or coal leases. Public Law 585 (August 13, 1954), called the Multiple Mineral Development Law, provides for mining claims and mineral leases on the same ground with neither the claimant or the lessee gaining rights to the other's mineral commodity.

There are no known conflicts with mining claims for other minerals in the area and no known deposits exist within the claimed area.

Surface disturbance on quarry sites would be approximately the same for both the Johns Valley proposal and the Canaan Peak alternative. The Canaan Peak

alternative would consume 60 percent less energy hauling limestone, therefore 60 percent less emissions would be deposited into the atmosphere. However, there would be 150 acres more of surface disturbance during construction of the Canaan Peak alternative than the Johns Valley proposal due to upgrading and construction of 25 miles of road. Such disturbance would result in an additional 0.02 acre-foot of sediment being deposited into Lake Powell each year until reseeding occurs. Effects of this sediment to the fisheries in Lake Powell is not known at this time.

Surface rehabilitation by seeding would have a probability of success of 5 to 7 years out of 10. After rehabilitation there would be a loss of 105 acres more vegetation on the Canaan Peak alternative than on the Johns Valley proposal due to physical occupation of road surface. This loss of vegetation would reduce grazing capabilities for an additional five head of deer and 30 animal unit months of livestock grazing when compared to the proposed site.

ALTERNATE ACTIONS BY GOVERNMENT AGENCIES

The following discussion lists possible alternatives that might be taken by state and federal agencies to implement actions by participants for development of the Kaiparowits project, and legal authorities for these alternative approaches.

Bureau of Land Management (BLM) - Federal

The Bureau of Land Management would be the only federal agency that could provide land for a town site or the power plant site. There are no meaningful alternatives for other federal agencies to implement the proposed project within their jurisdictions.

The State of Utah has filed application for indemnity lieu selections to acquire federal lands that would be needed for either the Fourmile Bench power plant site or the Nipple Bench power plant site.

There are several approaches whereby federal lands could be utilized for the generating plant and town site. (See Appendix VIII-1). Most of the approaches available for the Kaiparowits project would require that lands pass from federal ownership, either to the State of Utah or to private.

The first approach would allow the State of Utah to acquire lands by filing an application under the State Grants Indemnity Selection as authorized by Sections 2275 and 2276 of revised Statutes, as amended (43 USC 851, 852). The law provides that a state may select equal acreage within its boundaries for grant lands lost to the state because of appropriation before title could pass to the state or because of natural deficiencies resulting from such causes as fractional sections and fractional townships. Lands would be selected generally from unappropriated, nonmineral public lands.

The second approach that could be used to pass title to the State of Utah would be a Quantity and Special Grant Selection, as authorized by Sections 2275 and 2276 of the Revised Statutes, as amended (43 USC. 851, 852). The law provides the state may select up to 6,400 acres, within a single selection, only

from vacant, unappropriated, nonmineral, surveyed public lands for support in aid of other school sections.

A third approach would be for the State of Utah to exchange state lands for federal lands as authorized by Subsections (c) and (d) of Section 8 of the Act of June 28, 1934 (48 Stat. 1272). When lands are exchanged with the state such an exchange is based on a value-for-value basis rather than acre-for-acre.

A fourth approach would be the issuance of a right-of-way for the power plant site. The Act of February 15, 1901, authorized the Secretary of Interior to allow the use of right-of-way for electrical plants, etc. This is probably not an acceptable alternative to the power companies; they have indicated they cannot obtain financing if they do not have fee title to the land.

In a meeting in October 1975 between BLM and Kaiser Engineers Corp., a fifth method of land transfer for the proposed new town site was considered. This method would consist of a private exchange of land between Kaiser and BLM. The lands would be exchanged on a value-for-value basis.

At this time none of the lands in question for either the power plant or town site would qualify for disposal under a town site entry. Such a disposal requires that the lands must be occupied by inhabitants prior to filing. These lands do not have occupancy at this time. However, before any public lands could be transferred these same lands would need to be classified by the Secretary of the Interior under Section 7 of the Taylor Grazing Act (43 U.S.C. SS 851, 852) which would remove the withdrawn status of these lands.

All of the approaches where lands are transferred, would be the same to the environment as no environmental restrictions could be included in the transfer document. The federal government would retain no control over what takes place on the land whatsoever. The only restrictions of an environmental nature that could be considered are the Kane County zoning regulations, which are limited in scope when

applied to an urban society rather than a rural society. Furthermore, no matter how adequate zoning regulations are they are no better than the county's willingness to enforce them.

The one approach that would allow government control and restrictions would be granting of a right-of-way. This would allow the government to enforce controls and stipulations beyond the life of the power plant and could eliminate some of the impacts anticipated from erosion of the waste disposal areas.

Kaiparowits Planning and Development Advisory Council

New town

The Kaiparowits Planning and Development Advisory Council (PDAC) selected Call Engineering, Inc., to study feasibility of designs and locations for a new town to meet housing needs related to the proposed project. Call Engineering provided a basic plan, suggested a site on East Clark Bench for primary consideration and suggested alternatives in planning and location.

Subsequently, Kaiser Engineers was selected by the participants to develop town plans. Their plan for a new town on East Clark Bench was presented to the PDAC and is the basis for the new town proposal described in Chapter I. Kaiser Engineers also provided a plan and analysis for a town on Fourmile Bench.

Alternatives in planning

Alternatives considered by Call Engineering included flexibility in design, alternative water supply, and alternative disposal of treated sewage effluent. Call Engineering suggested that the basic plan be used, but that a developer could modify the plan if needed. Further study of a site and refinement of the plan could provide greater compatibility with terrain and within the town, and help provide adequate housing at appropriate times. The opposite effects could also occur, however, which emphasizes the importance of planning efforts.

Flexibility in planning for the East Clark Bench site includes expansion of the initially-defined area to include a state-owned section of land (Section 16, T. 43 S., R. 2 E.). This is intended as a contingency measure, which would permit construction of housing early enough to avoid or reduce disadvantages of hastily-constructed living facilities in case of delay in transferring land for a town site. Use of the state land would result in a town that would straddle U.S. Highway 89, and require mitigating measures to reduce

traffic problems and hazards. Environmental impacts would be much the same as those of a town oriented entirely north of U.S. 89. Access to a site on state land would require a right-of-way over federal land, which would not be granted in advance of approval of the proposal.

Water would come from deep wells on or near the site. An alternative would be water from Lake Powell, through a 24-inch pipe line from the proposed power plant water pipe line. It could also become necessary to use subsurface water from wells at some distance from a town site. In either case, construction of a pipe line would require a right-of-way and cause physical impacts which would need to be mitigated. The alternative generating station water pipe line route along the proposed highway would be nearer than the proposed pipe line route to the East Clark Bench site. The municipal water line would, therefore, be shorter if it were connected at the nearest point, thus reducing cost of development.

Treated sewage effluent is proposed to be used for irrigation. Suggested applications include irrigation of pasture crops or the proposed golf course, or disposal in evaporation and percolation ponds. Any of these methods would cause local changes in environment by increasing amount of water in soil. Specific impacts would depend on location, disposal method, and amounts of effluent. As these amounts are not known at this time the increase in soil water cannot be quantified.

Call Engineering also mentioned Nipple Bench as a town site. In addition, a fifth alternative, also located on East Clark Bench about 7 miles west of the primary proposal, is considered here (see Illustration VIII-111 for location). Figure VIII-24 indicates physical and location characteristics of these sites, all of which are in Kane County. It describes the existing environments, and also provides some data regarding potential conditions if a town were developed at any of the sites. Call Engineering suggested that the town plan for East Clark Bench could be adapted to alternative sites.

FIGURE VIII-24

Characteristics of Proposed and Alternative Town Sites

Factors	East Clark Bench (primary site)	Butler Valley	Long Flat	Fourmile Bench	Nipple Bench	East Clark Bench alternate
Location	T. 42 & 43 S. R. 2 E.	T. 38 & 39 S. R. 1W & 1E.	T. 39 S. R. 1 & 2 E.	T. 39 & 40 S. R. 2 E.	T. 42 S. R. 3 E.	T. 43 S. R. 1 E.
Approximate acreage proposed for acquisition[a]	5,000	4,800	5,440	5,280	-	-
Average elevation above mean sea level (feet)	4,200	6,300	5,800	6,200	5,200	4,700
Estimated average annual precipitation (inches)	6.3	11-12	10-11	9-10	8-9	6-7
Estimated average January temperature	32°F	27°F	28°F	27°F	29°F	31°F
Estimated average July temperature	82°F	69°F	72°F	70°F	80°F	82°F
Approximate length of frost-free season (days)	180-200	120-140	140-160	140-160	140-160	160-180
Dominant vegetative type	mixed desert shrub	sagebrush[b]	sagebrush	pinyon-juniper	brush & grass	mixed desert shrub
Soils	sand & sandy loam; minor, scattered gypsum; moderate erosion susceptibility	loam; partly gypsiferous; moderate erosion susceptibility	loamy; fine to medium texture, contains expandable clay, highly erosive	medium texture; shallow; moderate erosion susceptibility	medium texture; shallow, moderate erosion susceptibility	sand & sandy loam; moderate erosion susceptibility

[a] About 3,900 acres would actually be utilized for town development. Larger acreages would be applied for to obtain flexibility in arrangement within the selected area.

[b] Presently seeded with crested wheat grass.

FIGURE VIII-24 (Continued)

Factors	East Clark Bench	Butler Valley	Long Flat	Fourmile Bench	Nipple Bench	East Clark Bench alternate
Sensitive biological features	antelope herd in vicinity			pinyon & juniper 500-700 yrs. old; some more than 1,400 yrs. old		antelope herd in vicinity
Topography & geology	gentle slope northward; steep sandstone outcrops to the south; deep drainage (Buck Tank Draw) in western portion	broad valley surrounded by hills	broad valley with numerous gulleys	low hills; cliffs surround bench on east, south & west	low hills and mesas; cliffs surround bench on east, south and west	gentle slope northward; steep sandstone outcrops south of site
Mineral resources underlying site	undetermined quantity and quality of gravel	thin, uneconomical coal beds; minor deposits of gravel; gypsum deposits nearby	possibly 60 million tons of coal; some gravel in streams and terraces	about 92 million tons of coal, 1900 feet deep or more	thin, low quality coal 600 feet or more	
Mineral leasing	oil and gas leases	oil and gas leases	oil and gas leases	oil and gas leases; adjacent coal leases	oil and gas leases	oil and gas leases
Land uses on and immediately adjacent to site	Glen Canyon City; U.S. 89; 230 kV transmission line; cattle grazing (450 AUMs); gravel quarrying; Utah State fish ponds; sightseeing	Cottonwood Canyon road (US 89-Cannonville); 69 kV transmission line; 230 kV transmission line, cattle grazing (800 AUMs); Grosvenor Arch	Cannonville-Fourmile Bench road; cattle grazing (143 AUMs); hunting	livestock and BLM roads; cattle grazing (740 AUMs); hunting; firewood gathering	livestock and BLM roads; cattle grazing (948 AUMs)	U.S. 89; cattle grazing (133 AUMs)

FIGURE VIII-24 (Concluded)

Factors	East Clark Bench	Butler Valley	Long Flat	Fourmile Bench	Nipple Bench	East Clark Bench alternate
Approximate distance to nearest community by existing road (miles)	Glen Canyon City - 0 Page, Ar. - 17	Cannonville-16	Cannonville - 22	Cannonville-30 Escalante - 34	Glen Canyon City - 27 Page, Ar.-43	Glen Canyon City - 7 Page, Ar.-23
Approximate distance by proposed highway to						
- Fourmile Bench plant site	32	15	9	2	18	37
- mining area	25	26	20	10	12	29
- Nipple Bench alternate plant site	16	34	28	18	1-2	21
Approximate shortest distance via proposed highway, where appropriate, to						
- Bryce Canyon National Park (headquarters)	70	33	39	46	62	63
- Escalante Canyon Outstanding Natural Areas (14 miles east of Escalante)	80	64	55	48	66	87
- Capitol Reef National Park (west boundary, near Torrey)	138	119	113	106	124	145
- Glen Canyon National Recreation Area (Wahweep Marina)	14	51	53	46	28	21
- Paria Canyon Primitive Area	14	32	38	46	28	7

Alternate town sites

The PDAC selected three sites as alternatives to the East Clark Bench location. These sites are in Butler Valley, Long Flat, and on Fourmile Bench. (See Illustrations VIII-112 through VIII-115).

Location may significantly affect quality of living and desirability of a site. Increased distances from U.S. 89 could lessen the likelihood of attracting additional business and industry, which would affect the longevity of a town in the event the plant and mine shut down. Higher elevation sites would be on the Cannonville-Fourmile Bench road, and would be affected by truck traffic from and to the limestone quarry. Commuting from sites that are farther from the plant site and mining area would require greater use of fuel. Similarly, greater use of fuel and of the proposed highway would occur if large numbers of residents wanted to "get away" on weekends. Higher sites would be less likely to discourage uncontrolled development of private lands along U.S. 89, but they may encourage some economic development in nearby parts of Garfield County through recreational use of federal lands. Distance from a town to the mining area would have more effect on fuel consumption than distance to the generating station, because a larger number of people would be employed in mining.

Restricted possibilities of expansion and the absence of suitable state land for contingency development, if required, could cause difficulties. Need for additional town sites or inability to develop adequate housing early enough, would result in congested and unplanned growth. East Clark Bench and Fourmile Bench sites appear to have the greatest advantages in these respects.

Sites at higher elevations (Butler Valley, Long Flat, and Fourmile Bench) would require energy for heating in winter, whereas sites at lower elevations would require less energy for heating, but would use energy for air conditioning in summer. Cold winters at higher elevation could make those sites less attractive for living.

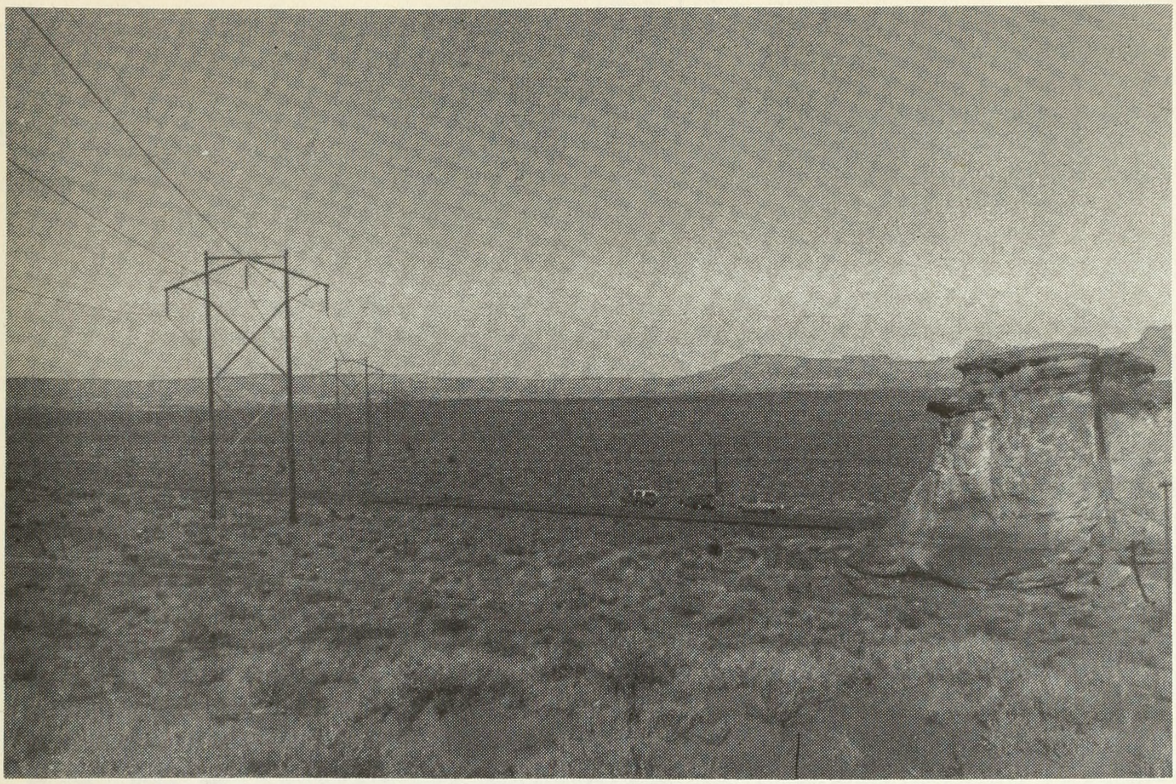


Illustration 111

East Clark Bench Primary Townsite

Illustration 112

Butler Valley Alternative Townsite (looking southwest)

Illustration 113

Long Flat Alternative Townsite (looking northwest)

Illustration 114

Fourmile Bench Alternative Townsite (looking south)

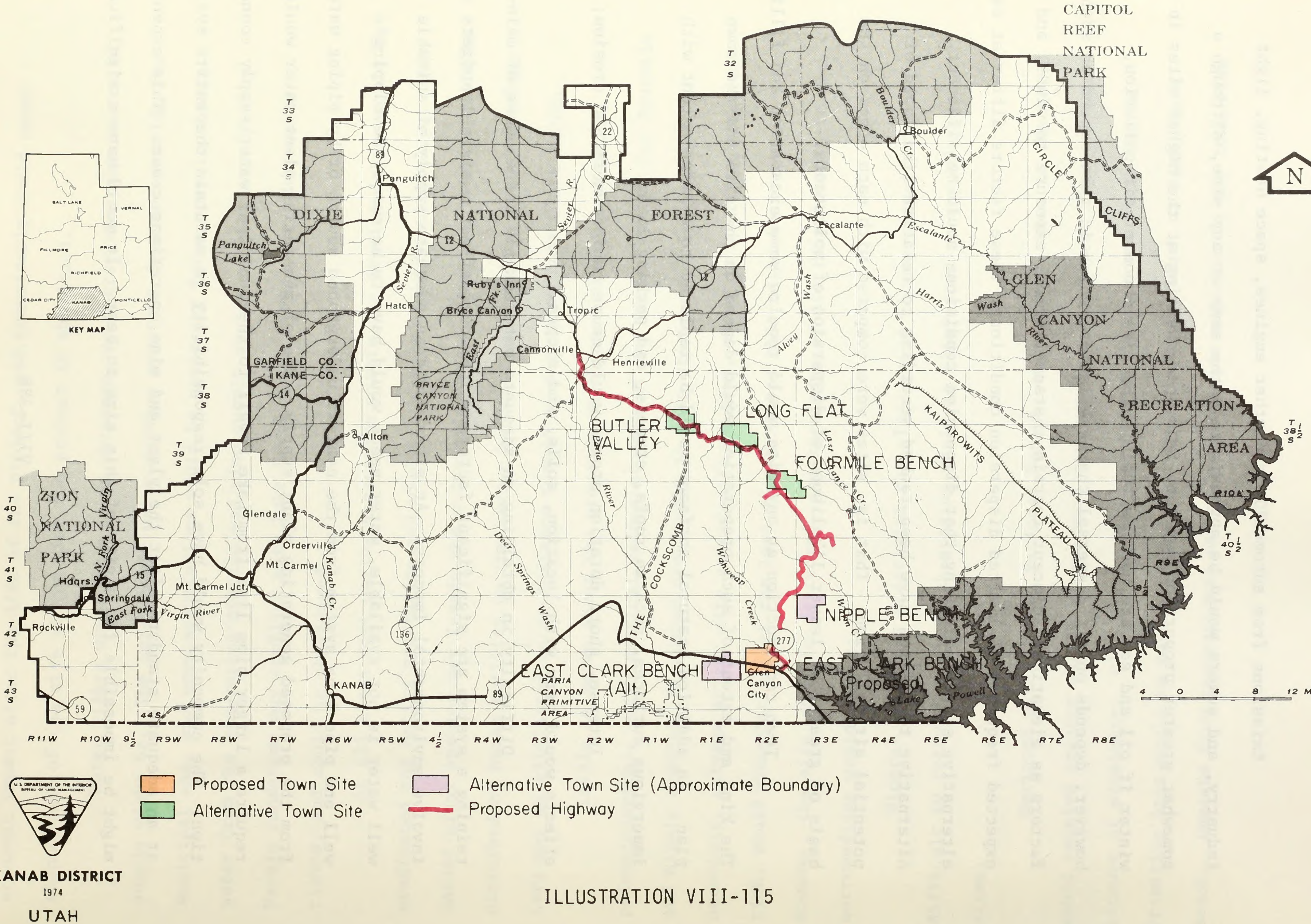


ILLUSTRATION VIII-115

Proposed and Alternate Town Site Locations

Emissions from automobile and other engines, space heating, light industry, and sewers would be approximately the same at any site, although a somewhat greater proportion may come from space heating at the higher sites in winter if oil and gas are used as fuels. The likelihood of air pollution, however, depends on air dispersal characteristics, which in turn depend on such factors as elevation, adjacent terrain characteristics, exposure to winds, and expected frequency of limited dispersion conditions. These factors differ at each alternative site, indicating that dispersion conditions could be different. Alternative town sites have been ranked according to relative likelihood of potential air pollution. That is, sites were compared with each other on the basis of greater or lesser likelihood of dispersion of pollutants.

Town construction at any site would require some excavation and filling. The kind and extent of such preparation would depend on the site and the town plan. In addition, natural surfaces would be replaced to a large extent with impervious surfaces, such as roofs, streets, and parking lots.

Intense, short duration storms would cause rapid runoff and erosion; effects would vary with location, soils, and slopes.

Difficulty in obtaining an adequate water supply and expense of maintaining a system are significant factors which would affect municipal budgets and involve environmental impacts. At sites where an adequate supply of suitable well water is not available, water needs would have to be met by developing a well and pipe line system from the nearest underground source or by piping water from the proposed generating plant supply. Use of generating plant water would require a larger pipe line from Lake Powell to the municipal water supply connection. The community would have sole responsibility to maintain the entire system at an adequate standard after the plant and mine operations cease. This expense might be impossible for a city of this size to bear. It would have a significant

economic impact after the life of the project, and conceivably could cause abandonment of the city at the time the project is abandoned.

Water rights would have to be obtained, no matter what the source of supply might be. The Lake Powell water service contract does not provide for municipal use, and some negotiations would be necessary for a town to obtain water from the generating station and mine supply system. Water supply from Navajo sandstone may conflict with Lake Powell bank storage or other water rights, and could be challenged.

At all sites most native vegetation within the developed area would be eradicated and native vegetation and wildlife nearby would be eliminated. Non-native plant species may invade the surrounding area. Deer and raptors would be disturbed by human activity on the higher benches, whereas the nearby antelope herd may be eliminated as an indirect result of a town on East Clark Bench.

Little is known about the presence or absence of archaeological, paleontological, and historical values at each of the sites, except for Fourmile and Nipple benches, discussed previously in this statement. Surveys and, if necessary, salvage at any site selected for a town, prior to starting construction, would somewhat offset the loss of any values that might be present. However, the site would be destroyed, and knowledge of its relationship to the surroundings would be lost.

Mineral resources underlying the sites could become unavailable or difficult to recover. Livestock grazing would be eliminated at any of the sites.

National parks, Dixie National Forest, and natural areas to the north would receive greater use if a town were developed on any of the higher sites because of proximity. Glen Canyon National Recreation Area and Paria Canyon Primitive Area would be more affected by a town on Nipple Bench or East Clark Bench. Impacts from recreational use of public lands adjacent to any town site

would be as described in Chapter III, but the predominant kinds of activity would vary somewhat with location of the town. Recreation at the higher sites would include increased wood and pinyon nut gathering, and hiking. Water-oriented recreation and off-road vehicle travel would be common near a town on East Clark Bench.

Air pollution may or may not be important, depending on the characteristics of each site and the effectiveness of emission controls. Land use conflicts would be important to utility companies having rights-of-way, to grazing licensees, town residents, and possibly to mineral developers. Aesthetic and recreational impacts are partly subjective as to their particular significance in each case, but are important to quality of the human environment and, if adverse, are difficult to mitigate. Potential hazards which are adjacent to some of the sites could possibly be mitigated by ordinances, fences, and other measures, but they too would affect quality of living.

A town at any of the alternative sites would involve the following effects when compared with each other and with the primary site, which has been analyzed in preceding chapters and is summarized here for comparison. Items listed are not in any order of importance. Figure VIII-25 is a simplified comparison of site conditions and potential effects.

East Clark Bench (primary alternate)

1. Adjacent to U.S. 89, which would require mitigating measures to reduce traffic hazards. Commuting time to mining area may be reasonable for most residents, but commuting time to Fourmile Bench plant site would be longer than from any other site except the East Clark Bench alternative site.

2. Usable space for expansion is present around the site and there is suitable state land for contingency development.

FIGURE VIII-25

Environmental Comparison of Proposed and Alternative Town Sites

Factors	East Clark Bench (proposed site)	Butler Valley	Long Flat	Fourmile Bench	Nipple Bench	East Clark Bench alternate
Relationship to proposed highway	terminus	adjacent	adjacent	adjacent	near	near
Estimated driving time[a] (minutes, one-way) to:						
- Mining area	33	35	27	13	16	39
- Fourmile Bench plant site	44	20	12	3	24	49
- Nipple Bench alternative plant site	22	45	37	24	b	28
- U.S. 89 (by proposed highway)	-	60	52	43	19	-
Sufficient space for expansion	yes	no	yes	yes	no	yes
Suitable State land available	yes	no	no	yes	no	yes
Conflicts with present and proposed land uses	230 kV transmission line; grazing; proposed 500 kV transmission lines	230 & 69 kV transmission lines; grazing	grazing	grazing	grazing	grazing
Potential conflicts with mineral development	oil and gas leases; bench gravel	oil and gas leases; minor coal, gravel, gypsum	oil and gas leases; minor gravel	oil and gas leases, coal leases in west part - coal at 1,900 ft. or deeper	oil and gas leases, thin, deep coal seams (probably not minable)	oil and gas leases
Strong possibility of adequate subsurface water	yes	no	no	no	no	yes

FIGURE VIII-25 (Concluded)

Factors	East Clark Bench	Butler Valley	Long Flat	Fourmile Bench	Nipple Bench	East Clark Bench alternate
Distance to proposed water pipeline from Lake Powel to Fourmile Bench (miles)	9	19	12	2	0	15
Potential aesthetic intrusion[c]	moderate	high	moderate	low to moderate	low	moderate to low
Major potential disturbances	off-road vehicle disturbance of sensitive Tropic Shale	Grosvenor Arch	-	mature stand of pinyon-juniper	-	off-road vehicle vehicle disturbance of sensitive Tropic Shale
Potential hazards	ravine with very steep sides; cliffs to south	-	-	cliffs at edges of bench	cliffs at edges of bench	rocks and cliffs to the south
Relative rank of sites for potential air pollution (1 = greatest probability 5 = least)	2	1	4	5	3	2

a Assuming an average speed of 45 miles per hour.

b There is not enough space on Nipple Bench for both a generating plant and a town.

c Based on proximity to vantage points, relative number of viewers, likelihood of blending with background, and natural screenings.

3. Air conditioning would be a necessity for most residents because of high summer temperatures. Space heating would also be necessary during at least 3 or 4 months. Potential for dispersal of air pollutants is probably less than at Fourmile Bench, but better than at Butler Valley.

4. Soils on the north side of U.S. 89, which would bisect the proposed community, are considered to be favorable or exhibit a minor degree of limitation for septic tank fields, sewage lagoons, dwelling, shallow excavations, sanitary landfill and roads and streets. Good performance and low maintenance costs can be expected from the above-mentioned facilities if placed north of U.S. 89.

Soils south of U.S. 89 within the immediate vicinity of Glen Canyon City, Utah, contain intrusions of gypsum deposits. Where gypsum deposits occur soils have moderate limitations for septic tanks, sewage lagoons, dwellings, shallow excavations, sanitary landfill and roads and streets because of soil instability and the potential for high shrink-swell ratio. This limitation can be overcome or modified by special planning, design or increased maintenance costs (see Appendix II-4 for a detailed description of soil limitation ratings).

5. Withdrawal of water from Navajo sandstone to supply a new town would increase ten-fold over the 1974 rate of withdrawal, and could affect the flow of Wahweap Creek. Disposal of sewage and solid waste on porous sandstones in the area could contaminate subsurface water, including the town's water supply. Water obtained from Lake Powell would require a pipe line, probably connected to the generating station water supply line, and would involve additional expense and impacts. The line would have to cross Wahweep Creek Canyon, and would either be visible or, if buried, might be broken by floods.

6. All vegetation, except perhaps in open space buffer zones, would be eradicated. The presence of so many people on East Clark Bench would probably lead to elimination of the small antelope herd in the vicinity.

7. The site is traversed by a 230 kV line, and the proposed 500 kV transmission corridor would cross the site, creating conflicts in land use. Grazing rights for up to 450 animal unit months would be lost at the site itself. Unknown amounts of bench gravel would become unrecoverable unless mined prior to town development.

8. A town would disturb scenic qualities, although disturbance would not necessarily be adverse to all viewers, especially if mitigated by planning and development and enforced ordinances.

9. Rock outcrops and a deep ravine within the site are potential hazards.

Butler Valley

1. Butler Valley is adjacent to the proposed highway, but the time required for commuting to the mine, Nipple Bench alternative site, and U.S. 89 could make the site undesirable to many potential residents, although it is relatively close to the proposed Fourmile Bench plant site (see Figure VIII-24). The site is farther from U.S. 89 than any other alternative, and this would discourage any economic growth that might be dependent on supply from the south. Nevertheless, the site is the closest to Garfield County and could induce some economic benefits in the Cannonville area. Location on the proposed highway would result in some traffic and noise problems from limestone delivery trucks from the proposed quarry.

2. A relatively small amount of usable space is available for expansion, and there is no suitable state land for contingency development included in the site.

3. Relatively cold winters would require space heating, but air conditioning would be optional. The site has potentially the poorest air pollution characteristics of any site. No studies have been performed, however, to determine whether air pollution would actually be a problem.

4. Soils consist primarily of alluvial fill with intrusions of gypsum. Where gypsum is lacking soils are considered favorable or exhibit a minor degree of limitation for septic tank fields, sewage lagoons, dwellings, shallow excavations, sanitary landfill, and roads and streets. Good performance and low maintenance costs can be expected from the above-mentioned facilities. However, where gypsum deposits occur soils have moderate limitations for septic tanks, sewage lagoons, dwellings, shallow excavations, sanitary landfill and roads and streets because of soil instability and the potential for high shrink-swell ratio. This limitation can be overcome or modified by special planning, design or increased maintenance costs. (See Appendix II-4 for a detailed description of soil limitation ratings.)

5. This site has a questionable potential for subsurface water supply. It might be necessary to obtain Lake Powell water through the power plant water pipe line. This would require an increase in the diameter of the proposed pipe line from Lake Powell to Fourmile Bench. This system would be longer than for any other town site (19 miles), and the most expensive to maintain if the power plant were eventually shut down. It would also involve the most environmental disturbance because of length and the necessity to cross ridges east of Butler Valley.

6. Part of the site is presently traversed by 230 kV and 69 kV transmission lines; this would be a conflict in land use. Up to 3,000 acres of land cleared by BLM and seeded with crested wheatgrass to increase grazing capacity, would be lost. Grazing rights for 800 animal unit months would be terminated. Relatively minor deposits of coal, gypsum, and gravel could become nonrecoverable.

7. A town at Butler Valley would be the most likely to disturb scenic qualities, and be the most visible from vantage points such as Rainbow Point in Bryce Canyon National Park. Scenic qualities of the site may attract residents, somewhat offsetting the fact that winter months may be too cold to suit many residents.

Long Flat

1. This site is also adjacent to the proposed highway, with potential for impacts due to limestone truck traffic, but it is closer than Butler Valley to the proposed plant and mine sites, Nipple Bench, and U.S. 89. A town at Long Flat may be less likely to stimulate growth in Garfield County than a town at Butler Valley.

2. Usable space is available for town expansion, but no usable state land for contingency development is included in the site.

3. Cold winters would require space heating, but air conditioning may be unnecessary. Like Fourmile Bench, Long Flat has relatively good potential for dispersal of air pollutants.

4. Soils in Long Flat have moderate limitations for septic tank fields, sewage lagoons, shallow excavations, dwellings, sanitary landfill and roads and streets due either to slopes in excess of 8 percent along the edges of Long Flat or soils with low permeability and a high shrink-swell ratio in alluvial bottoms. This limitation can be overcome or modified by special planning, design or increased maintenance costs. (See Appendix II-4 for a detailed description of soil limitation ratings.)

5. The potential for adequate subsurface water is questionable. The same conditions for using water from Lake Powell would apply as at Butler Valley, except that municipal water pipe line length would be about 7 miles shorter and cost of maintaining the system should therefore be reduced. If the generating station were located at Nipple Bench, the nearest point from which to obtain Lake Powell water would be from the pipe line to the mine. In this case, the municipal supply pipe line would be about 21 miles long.

6. Small amounts of gravel in creek bottoms could be lost unless removed prior to development. Grazing for 143 animal unit months would be excluded.

7. A portion of the site may be visible from Rainbow Point in Bryce Canyon National Park.

Fourmile Bench

1. Fourmile Bench is adjacent to the proposed highway and closest of all the sites to the mining area and proposed plant site. It is relatively close to the Nipple Bench alternate plant site. The site is somewhat isolated from U.S. 89, but closer than Butler Valley and Long Flat. This site may be the most centrally located with respect to potential coal-based projects in the Kaiparowits area. If the plant were built at Nipple Bench, a town at Fourmile Bench would be on the limestone truck route, with associated noise and traffic impacts.

2. Sufficient usable space is available to allow future expansion. Usable state land is included in the site for contingency development, but its use prior to transfer of land for a town site would require a right-of-way.

3. As at the other high, northern sites (Butler Valley and Long Flat), space heating would be needed in winter, but air conditioning would be optional.

4. Soils on Fourmile Bench are favorable or exhibit a minor degree of limitation for shallow excavations, dwellings without basements, area-type sanitary landfill and roads and streets. Good performance and low maintenance costs can be expected from the above-mentioned facilities. However, due to shallow soil cover on Fourmile Bench these soils would be unfavorable for such uses as dwellings with basements, trench-type sanitary landfill, and as a source of cover material for area-type sanitary landfill.

These soils would have moderate limitations for septic tanks, due to low soil permeability, and for sewage lagoons, due to slope. These limitations can be overcome or modified by special planning, design or increased maintenance costs. (See Appendix II-4 for a detailed description of soil limitation ratings.)

5. Subsurface water supply would probably be insufficient and a relatively short pipe line, about 2 miles in length, would be necessary to use Lake Powell water. If the generating station were built at Nipple Bench, the pipe line would be at least 13 miles long. A more feasible supply system would be a 7-mile pipe line from the mine supply system, but the mine pipe line would need to be about 3 times the proposed diameter of 8 inches.

6. The mature stand of pinyon and juniper at the site would be adversely affected by construction of a town. Although careful planning and development could preserve many trees to act as noise, wind, and visibility buffers, the probability of firewood gathering, which might eventually include damage of live trees, could offset any mitigating measures. Most or all of Fourmile Bench would cease to be deer habitat.

7. The potential impacts on archaeological and paleontological values would be similar if a generating station or town were built on Fourmile Bench. However, it is likely that many town residents would hike all over Fourmile Bench, and that all archaeological and surface paleontological values which may exist would be lost.

8. Town construction could preclude mining of coal seams that underlie Fourmile Bench at depths of about 1,900 feet. Part of the western portion of the site is on the El Paso Natural Gas coal lease. Grazing would also be lost (740 animal unit months).

9. The site is immediately adjacent to the proposed plant site, which may detract from the quality of living at that location.

10. Cliffs that bound Fourmile Bench a few miles to the east and west are potential hazards.

Nipple Bench

1. Nipple Bench is near the proposed highway and only a few minutes driving time from Fourmile Bench, the mining areas, and U.S. 89.

2. There is insufficient usable land available for both a power plant and a town. Expansion of a town would be limited by the size of the bench. No usable state land is available for contingency development.

3. Both space heating and air conditioning would probably be needed. Windiness may be an undesirable trait, and exposure and soil characteristics may tend to make dust a problem. However, there is relatively small likelihood of air pollution due to the presence of a town.

4. Soils on Nipple Bench are favorable or exhibit a minor degree of limitation for septic tank fields, shallow excavations, dwellings, sanitary landfill, and roads and streets. Good performance and low maintenance costs can be expected from these facilities. These soils have moderate limitations for sewage lagoons due to slope in excess of 3 percent. This limitation can be overcome or modified by special planning, design or increased maintenance costs. (See Appendix II-4 for a detailed description of soil limitation ratings.)

5. Subsurface water supply may be insufficient, but the site is on the proposed power plant water pipe line, and tapping the generating station water supply system would be less expensive and result in fewer impacts than at any other alternative town site.

6. All grazing would be eliminated (948 animal unit months). No known mineral values would be made unrecoverable.

7. Archaeological values that have been found on Nipple Bench would be lost, along with others that may exist, unless surveys and salvage could recover them.

8. A town would not be visible from most vantage points, but the view from the town would be limited to the nearby skyline and the edges of benches to the north.

9. Cliffs that surround Nipple Bench to the east, south, and west at short distances from any possible town site are potential hazards.

East Clark Bench (secondary alternative)

1. This alternative is adjacent to U.S. 89, but is the farthest of all sites from Fourmile Bench plant site and mining area. It is less than 30 minutes driving time from Nipple Bench alternative plant site, however. If the town were developed on both sides of U.S. 89, measures would be required to reduce potential traffic hazards.

2. It may be less likely than the primary site to become economically diversified, because it would not be at the junction of U.S. 89 and the proposed highway.

3. Sufficient usable space is present for considerable expansion. Usable state and private lands for contingency development are nearby.

4. As at the primary site on East Clark Bench, air conditioning would be necessary for most residents at this site. Likelihood of air pollution is also probably less than at Butler Valley but greater than at Fourmile Bench.

5. Soils lying on both sides of U.S. Highway 89 are considered to be favorable or exhibit a minor degree of limitation for septic tank fields, sewage lagoons, dwellings, shallow excavations, sanitary landfill, and roads and streets. Good performance and low maintenance costs can be expected from the facilities if placed in this area. (See Appendix II-4 for a detailed description of soil limitation ratings.)

6. If sufficient subsurface water is not available on or near the site, a pipe line from the power plant water supply line would be up to 7 miles longer than at the primary site.

7. The nearby antelope herd would probably be eliminated.

8. As at other sites, grazing (133 animal unit months) would be eliminated. There are no known mineral resources which could become unrecoverable. This site would avoid the incompatibility at the primary site with the existing 230 kV transmission line and the participants' preferred 500 kV transmission line routes.

9. Rock outcrops to the south are potential hazards.

Mitigating measures

No specific mitigating measures have been proposed for the alternative sites. In general, mitigating measures suggested for the proposed site would be applicable at any alternative site, but some variations may be required according to locality. Most mitigating measures would depend on the town developer and on passage and enforcement of appropriate and applicable ordinances. Because land would be transferred out of federal ownership, federal agencies would not have jurisdiction in town.

Any adverse effects which cannot be avoided should the proposal be implemented

Grazing, natural vegetation, and wildlife would be eliminated in the developed area at any site, and would be eliminated or affected over a surrounding, larger area, depending on decisions of livestock operators and behavior of new town residents. Mineral resources would become unrecoverable, unless mined prior to town construction, and exploration for mineral resources would be precluded. Any cultural (archaeological and historical) values which may be present at any of the sites would be lost, unless salvaged prior to construction. Degree and nature of these adverse effects would vary with each site according to the environmental characteristics and present use of land as indicated in Figure VIII-24.

Summary

A town at any of the higher sites (Butler Valley, Long Flat, and Fourmile Bench) would result in greater overall environmental disturbance, except to antelope, and be more expensive to maintain than a town at the lower sites. It is highly probable that increased human activity and unplanned development would eventually eliminate the antelope population on East Clark Bench even if the town were located at one of the higher sites. Long Flat and Fourmile Bench would be

better located with respect to the proposed generating plant and mining area and would have lower potential for air pollution than sites on East Clark Bench. A town on Nipple Bench would result in relatively less environmental disturbance than a town at the higher sites, but would be restricted in possibilities for growth and would be more isolated than a town on East Clark Bench. The alternative site on East Clark Bench would be similar in most respects to the proposed site with regard to environmental considerations, but would be less convenient for commuting to mine and generating plant.

No transfer of land for town development

If a sufficient area of land is not transferred for town development, the result would be scattered, more or less independent housing on private and state lands and abrupt growth of nearby communities such as Page, Glen Canyon City, and Cannonville. Within about 35 miles of Fourmile Bench and the mining area near the proposed highway, there are about 16,000 to 17,000 acres of private and state land. Except for the area around Cannonville and Kodachrome Basin State Park, however, none of this land is in parcels larger than 640 acres. Some of these sites would not be suitable for housing because of rough terrain or lack of access, so the total that could potentially be used is less than 16,000 acres.

Control of such developments would be difficult. Sewage and solid waste disposal and water supply would be scattered and present significant adverse health problems. Expansion of any site would be severely limited. Services and facilities in existing communities would be strained. Small tract disposal by the Federal Government would have relatively few mitigating values, and would not prevent the kinds of impacts cited for the proposed and alternative town sites. Impacts would be cumulative over a large area. Trespass on federal lands for additional housing space could occur.

New highway

The Kaiparowits Planning and Development Council, through its Access - Highways Work Group, has been studying and developing alternatives for an access system related to the Kaiparowits power project. The work group submitted its formal recommendations to the Planning and Development Council for consideration and approval November 18, 1974.

The Planning and Development Council and executive committee approved the recommendations of the work group November 18, 1974.

It is the basic action proposal of the Planning and Development Council that:

> "The Access - highways system planned and constructed to support the Kaiparowits Power Project and proposed New Community should be a 'through system' from Cannonville in Garfield County (on the North) to the Glen Canyon City (East Clark Bench - New Community Site) on the south - US 89."

Four road systems were studied as possible routes for the new highway. One of these four routes was chosen by the Kaiparowits Planning and Development Council. This route is described in Chapter I. The three routes that were not chosen remain as alternatives to the proposed route.

Alternative I - This alternative is made up of four segments: Cannonville to Fourmile Bench; Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run; Nipple Spring to coal mine and Nipple Spring to Nipple Bench (if plant is built on Nipple Bench). (Illustration VIII-116). The following is a description of these segments.

Cannonville to Fourmile Bench - This existing dirt road is approximately 29.8 miles long. This segment would be the same for the proposal and all alternatives. Included in this segment would be 39 stream crossings and a maximum grade of 8 percent for approximately 1 mile of the total distance. Except for the few sections of 8 percent grade, vertical alignment would traverse gently

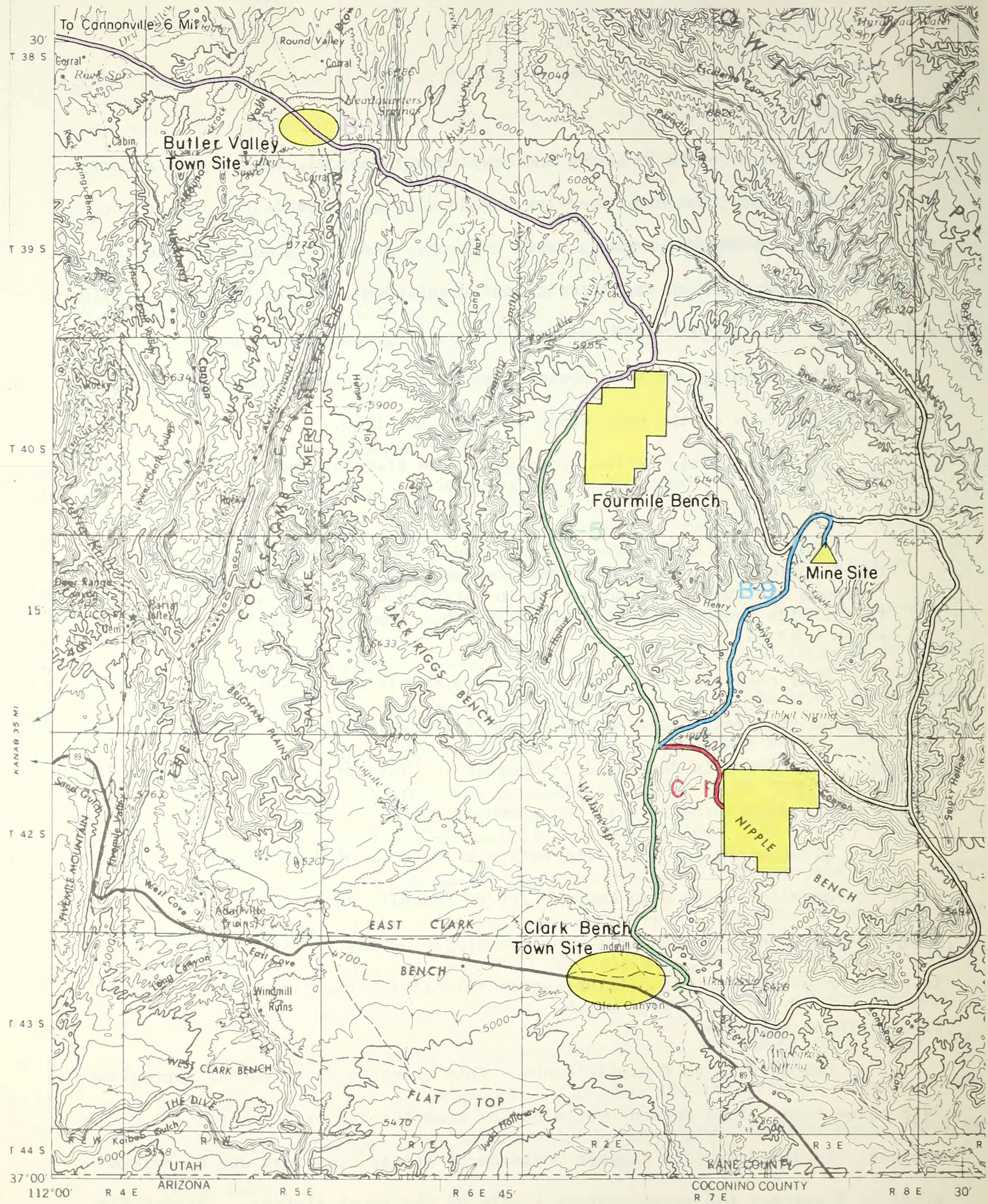


ILLUSTRATION VIII-116

Fourmile Bench and Nipple Bench
Access Road Alternatives

rolling terrain with all other grades being less than 6 percent. One of the few areas of heavy construction on this segment of highway would be through the area known as "The Gut" which is adjacent to Grosvenor Arch. Geologic formations are steeper at this point and would require some short sections of moderate cuts and fills. Aggregate could be obtained from Wahweap Creek, Paria River, the hills of Round Valley and on Horse Mountain.

Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run - This would be a 25.2 mile road with a continuous 1-1/2 mile 7 percent grade. Other than the 7 percent grade in Smith Run, the general terrain would allow a 4 percent grade or less. This road segment would require nine stream crossings. Wahweap Creek and Horse Mountain would be the best sources of aggregate. A short section in Nipple Creek would contain an exposed shale layer which has very poor road building characteristics. This shale would have to be kept as moisture free as possible and probably would be excavated to a sufficient depth that its swelling characteristics could be controlled.

Nipple Spring to coal mine - This segment would be 12.9 miles in length. Road grades would be less than 3 percent and 16 stream crossings would be included.

Nipple Spring to Nipple Bench - This road segment would be approximately 3.9 miles long, with no grades steeper than 4 percent. This segment would contain no stream crossings. Aggregate would be brought from Wahweap Creek.

The total length of this route would be 67.9 miles not counting the 3.9 miles to the Nipple Bench site and would require approximately 874,000 cubic yards of aggregate. The 3.9 mile segment to Nipple Bench would require approximately 46,800 cubic yards of aggregate.

Impacts to the environment would be the same as those identified in Chapter III.

Alternative II - This alternative is made up of three segments: Cannonville to Fourmile Bench; Glen Canyon City to Fourmile Bench via Nipple Creek, coal mine, Last Chance Creek and Paradise Canyon; and Nipple Spring to Nipple Bench (if plant is built on Nipple Bench). See Illustration VIII-117. The following is a description of these segments:

Cannonville to Fourmile Bench - This segment would be the same as described for Alternative I.

Glen Canyon City to Fourmile Bench via Nipple Creek, the coal mine, Last Chance Creek and Paradise Canyon - This segment would be approximately 45.6 miles long and have 43 stream crossings. A maximum grade of 6.8 percent continuous for 1.4 miles, would be required on this segment. All other grades would be less than 5 percent.

Nipple Spring to Nipple Bench - This segment would be the same as described for Alternative I.

The total length of this route would be 75.4 miles not including the 3.9 mile segment to the Nipple Bench site and would require approximately 964,800 cubic yards of aggregate, and 46,800 cubic yards for the Nipple Bench segment.

This alternative would result in 12 percent greater sediment deposition in Lake Powell than would the proposed route because of the larger areas that would be disturbed and occupied by the highway and increased need for road aggregate. Also the currently undisturbed areas of Last Chance Creek would be opened to public access and resident deer and cougar could suffer from the pressure of recreationists.

Alternative III - This alternative is made up of three segments: Cannonville to Fourmile Bench; Glen Canyon City to Fourmile Bench via Warm Creek, coal mine and Wesses Canyon; Warm Creek to Nipple Bench via Tibbet Canyon (if plant is built at Nipple Bench). See Illustration VIII-118.

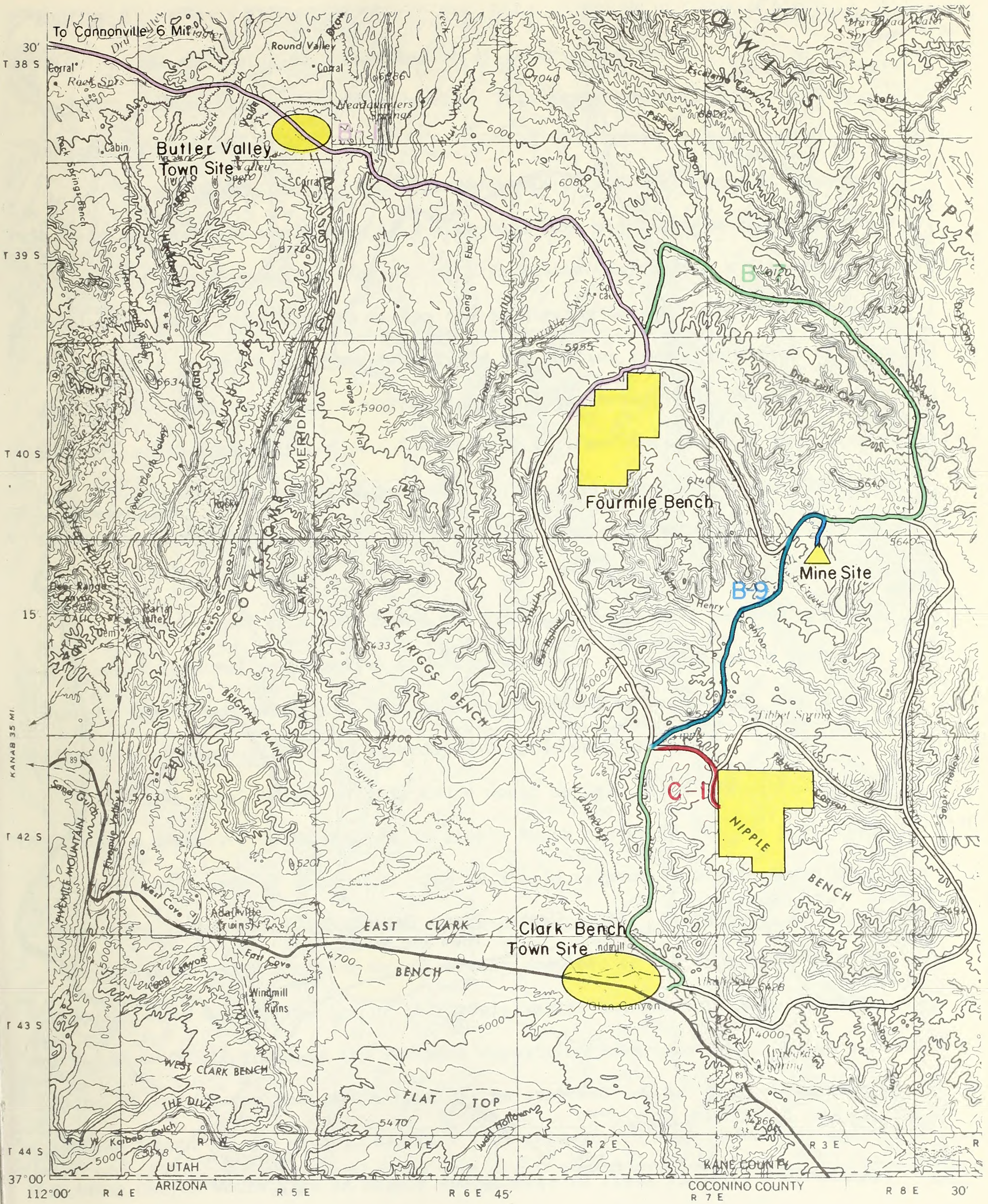


ILLUSTRATION VIII-117

Fourmile Bench and Nipple Bench
Access Road Alternative II

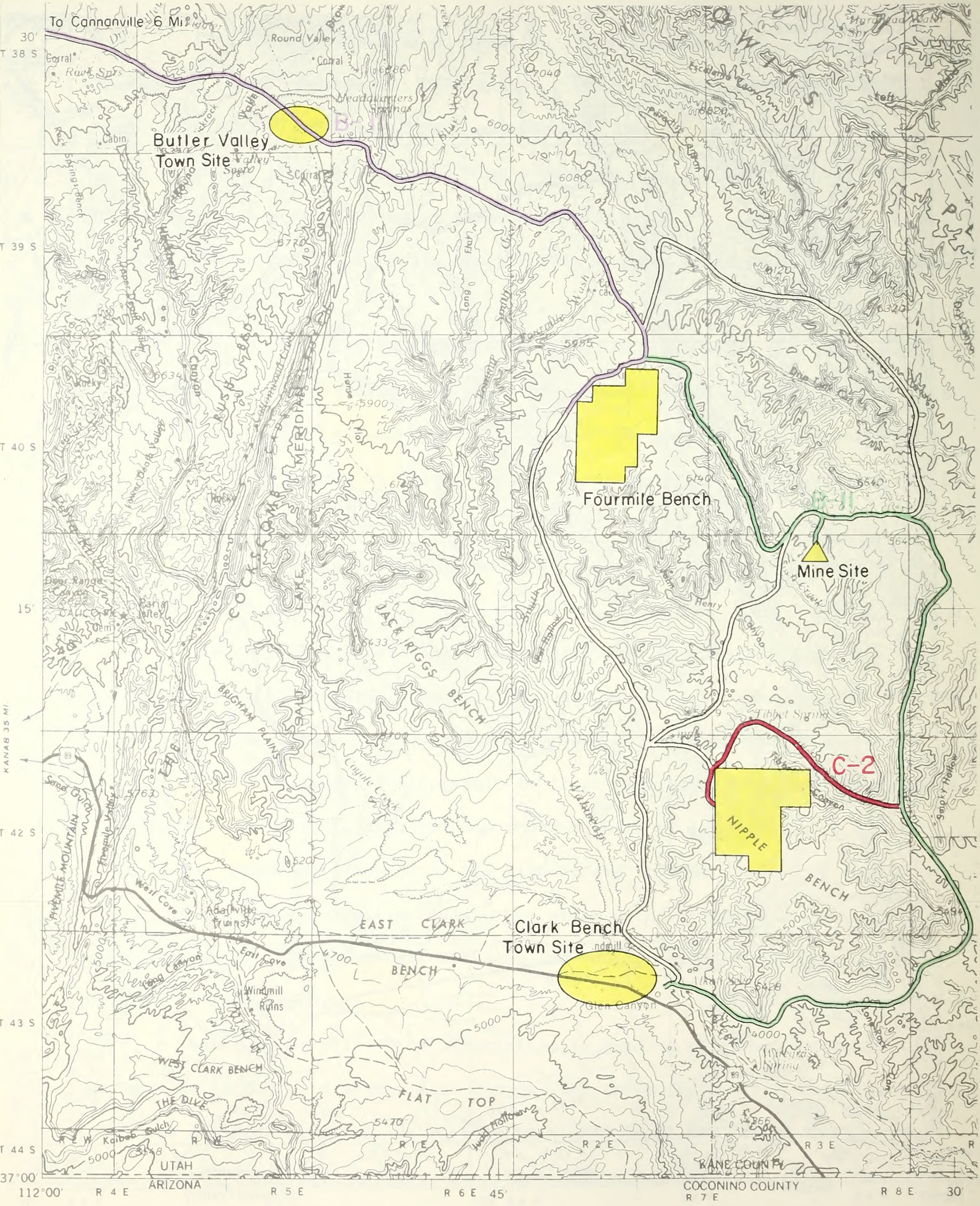


ILLUSTRATION VIII-118

Fourmile Bench and Nipple Bench
Access Road Alternative III

The following is a description of these segments:

Cannonville to Fourmile Bench - This segment would be the same as described for Alternative I.

Glen Canyon City to Fourmile Bench via Warm Creek, the coal mine and Wesses Canyon. This would be a 41.2 mile road with eight stream crossings and a 7.5 percent continuous grade for 0.7 mile in Wesses Canyon plus a 6 percent continuous grade for 1.5 miles at the top of Missing Canyon. An exposed layer of Tropic shale is found quite extensively in the section from Glen Canyon City to Warm Creek. This shale has a high shrink-swell ratio resulting in poor road building characteristics and would need to be kept moisture-free or excavated to such a depth that its swelling characteristics could be neutralized. Aggregate sources would be Wahweap Creek, Horse Mountain, and small quantities from Warm Creek.

Warm Creek to Nipple Bench via Tibbet Canyon - This segment would be 10.3 miles long and contain five stream crossings. It would have no grades steeper than 3 percent. Some aggregate can be found in Warm Creek, but additional supplies would have to be brought from Wahweap Creek.

The total length of this route would be 76.0 miles not including the 10.3 mile segment from Warm Creek to Nipple Bench and would require approximately 912,000 cubic yards of aggregate. The 10.3 mile segment to Nipple Bench would require approximately 123,600 cubic yards of aggregate. Disturbance to vegetation and soils would increase by 23 percent compared to the proposed route. Also, erosion characteristics of the Tropic shales and the increased surface disturbance could increase the sediment deposition into Lake Powell by as much as 25 to 30 percent per year above that of the proposed route. This could have an adverse impact on the aquatic habitat. The segments through Warm Creek and Missing Canyon would also be highly susceptible to flash flooding from summer storms.

ALTERNATIVE MEANS OF MEETING PROJECT OBJECTIVES

The implied purpose of the Kaiparowits Project is to permit the participating companies to furnish adequate power to their customers. Several means may be chosen, including the purchase of power from other sources, the choice of other fuels, and energy conservation practices.

<u>Purchase power from outside Kaiparowits market area</u>

Assuming availability of transmission facilities, purchase of power from another area would be possible only if utilities had surpluses or were willing to add capacity for the purpose of providing power to the Kaiparowits market area.

All utilities are facing problems of siting, obtaining permits for, and financing generating facilities for their own needs.

Ball (1972) notes that, based on a projected growth rate of 8 percent per year (the average over the past few decades) "Estimates by the utilities and the California Public Utilities Commission indicate that between 80,000 and 90,000 MW of new capacity must be added to the system by 1991 to meet the expected demand" (p.vi, Summary). Doctor (1972), discussing the slowing of the growth rate of electricity use, states (p. v, Summary): "California's electric utilities predict a slight slowing of the growth rate to 6.7 percent by 1990. The Federal Power Commission (San Francisco) predicts a further slowing in California's electricity growth to 5.8 percent by the year 2000." Doctor further notes that at a 3 percent growth rate, California's power plant capacity would still need to increase by 27,000 MW between 1970 and 2000. It is common practice for utility companies to buy and sell power to each other on a short-term basis, but according to the above analysis, most of the nearby power utilities will find themselves short on generating capacity unless new power plants are built. A radical slowing of the growth rate of electrical power use to 3 percent would

have the effect of delaying the need for the 3,000 MW to be generated by a Kaiparowits type plant but would not eliminate the need for the power. Utility companies would thus find themselves competing for the available power.

Therefore, the purchase of power from outside the Kaiparowits market area probably would not be a practical alternative.

Natural gas

All fossil-fueled steam electric generating plants have about the same requirements for space and water; consequently, environmental effects resulting from uses of space and water would be much the same for any site no matter what the fossil fuel used.

The use of natural gas could reduce air pollution through reduction in SO_2 and particulates emissions in the flue gases. Emissions of NO_x would not be materially reduced, since production of NO_x is largely a function of the combustion temperature with both nitrogen and oxygen available from the air used in combustion.

Natural gas may become available. The proposed Alaska Natural Gas Transportation System would deliver natural gas via pipeline from the North Slope of Alaska to the market area (U.S. Dept. of the Interior, Alaska Natural Gas Transportation System, Draft Environmental Impact Statement, June 1975).

However the United States has been consuming natural gas faster than the discovery of new sources (FEA, 1974). The proven reserves for natural gas as of 1973 were 218.3×10^{12} cubic feet for the lower 48 states and about 250×10^{12} cubic feet for the entire United States. At the current annual production rate, the life of these reserves would be 10 to 11 years (Univ. Okla., 1975). It is also reasonable to expect that the present artificially low price of natural gas will continue to stifle exploration for new sources. If the price of natural gas were allowed to float, it would be reasonable to expect higher prices for natural gas, with higher costs of generating electricity.

The nationwide concern over available natural gas and the small size of proven reserves would make construction of a large new electric power plant fired by natural gas a poor choice.

In addition, such a natural gas-fired plant could not be constructed in southern California, near the market area, because of the difficulty of even a natural gas plant meeting the NO_x emission standards of California Air Pollution

Control Districts' Rules 67 and 68 which set maximum allowable emissions of particulates, SO_2, and NO_x in the flue gasses, both as concentrations and as total quantities (Ball, et al., 1972).

Oil

Oil-fired steam electric generating plants to be built in southern California would come under the same Rules 67 and 68 of the California Air Pollution Control Districts mentioned above. The Rand study (Ball, et al., 1972) says in part: "Existing power plants burning either gas or oil can comply with current regulations on SO_2 and particulate emissions without having to install emission-control equipment, but they will need new equipment to control the combustion conditions in the boiler in order to comply with Rule 68 on NO_x emissions. That is within the state of the art. . . . On the other hand, large new power plants will have problems complying with Rule 67-type regulations. These regulations have the effect of restricting the size of a plant because they limit emissions to a certain absolute number of pounds per hour irrespective of plant size. . . . Emission controls (for particulates and SO_2) will be needed when burning residual oil. Again they are within the state of the art. The regulations on NO_x, however, impose limits for large power plants that are beyond the capabilities of current technology if the plant has a power output much greater than 300 MW. . . . Research is being conducted on methods of removing NO_x from power plant flue gases to reduce the concentration to much less than 40 ppm (the present practical limit), but those techniques are not expected to be commercially available for a number of years."

However, an oil-fired steam electric generating plant outside California could be an alternative to the Kaiparowits project, if the oil were available.

United States reserves, comprising that oil which can be economically extracted now, are estimated to be about 50 x 10^9 barrels, about a 9-year supply, although recent estimates of total U.S. oil resources range from 810 x 10^9 barrels down to 88 x 10^9 barrels (Univ. Okla., 1975). Domestic oil production could be increased through a price rise, subsidies, increased federal leasing,

release of Naval and Alaskan National Wildlife petroleum, production from the Alaskan North Slope and the Outer Continental Shelf, and/or direct federal production or allocation (USDI, Bur. of Rec., WESCO DEIS, Dec. 1974).

The United States presently imports 35 percent of its daily oil consumption (FEA, 1974). However, oil supplies which the United States seeks to import will continue to become more costly and limited as competition for supplies of energy increases (USDI, Bur. of Rec., WESCO DEIS, Dec. 1974).

Thus, an oil-fired power plant would place an increased burden on already small reserves, national and world-wide, and could adversely affect U.S. balance of payments.

An oil-fired power plant would consume about the same amount of water as a coal-fired one. Local effects near an oil-fired plant would be much the same, except that particulates and SO_2 emissions often can be reduced substantially below levels permitted under federal air quality standards.

Oil shale

U.S. oil shale reserves contain more energy than the total U.S. oil and natural gas reserves (Univ. Okla., 1975).

Commercial production of synthetic crude oil from oil shales has not yet begun in the United States, but there are indications that production may become feasible in the near future, especially if accompanied by a moderate rise in crude oil prices. The discussion below is compiled largely from the Ford Foundation report (Freeman, 1974), Energy Alternatives (Univ. Okla., 1975), and the WESCO Draft EIS (Bur. of Rec., Dec. 1974).

The U.S. Geological Survey has estimated total U.S. oil shale deposits (producing 5 gallons of oil per ton and up) to be in excess of 2×10^{12} (two trillion) barrels of oil, of which 418×10^9 would be from deposits producing 25 barrels per ton or more. Of this, an estimated 160×10^9 barrels lie in beds more than 25 feet thick, average 30 to 35 gallons per ton, and lie less than 1,000 feet below the surface. Of these deposits, 80×10^9 barrels are considered to be recoverable by room-and-pillar mining and retorting above ground. Some of this latter fraction may be recovered through open-pit mining. Development is being undertaken which may lead to economic in situ retorting.

The most important known oil shale deposits in the United States occur in the Green and Colorado river basins in Wyoming, Colorado, and Utah. These include all the known high-quality oil shales.

Oil shales consist of solid, mostly insoluble organic material in a mixture of inorganic materials. When heated, the organic material pyrolyzes to oil, gas, and coke. In practice it is expected that most of the gas would be used to power the operation and to hydrolize the synthetic crude oil (syncrude) in the refining process. Three types of above ground retorting have undergone pilot plant testing: the Bureau of Mines' gas combustion retort, the Union Oil

Company's "A" retort, and the Oil Shale Corporation's TOSCO II retort. The Bureau of Mines method has spawned secondary development in other countries.

Two methods of in situ retorting have been undertaken, a Bureau of Mines method and the Garrett process. In both cases, fracture of the oil shales must take place before retorting.

Above ground retorting is expected to require no ancillary energy. In situ retorting has ancillary energy requirements equal to about 6 percent of the energy value of the oil shale recovered; additionally, recovered gases would be only about 50 British thermal units per standard cubic foot, so low that off-gases would be replaced or supplemented with natural gas to maintain the in situ combustion.

Oil shales can be retorted, refined and reformed (catalytic hydrogenation) into a variety of products, including high grade gasoline, fuel oils, jet fuels, distillate fuels, solvents, paraffin wax, asphalt, tar acids, tar bases, coke, and petrochemical plant feed stocks such as ethylene, propylene, butylene, benzene, and naphtha, plus salable quantities of sulfur and ammonia.

Environmental impacts from a large-scale shale oil production could be severe. Environmental data are presented in Figures VIII-26 and -27, for both 10^{12} Btu inputs and for the equivalent of a 3,000 MW power plant (nearly 9 x 10^{13} Btu/yr). The different oil shale refining processes are expected to produce differing quantities of waste products, but an average among them indicates that shale oil production having the equivalent energy value of a 3,000 MW power plant would produce about 2,400 tons/year of particulates, 9,600 tons/year of oxides of nitrogen, about 60,000 tons/year of the oxides of sulfur, about 33,000 tons/year of various hydrocarbons, 2,200 tons/year of carbon monoxide, 92 tons/year of various aldehydes, and 50 million tons/year (about 37 million cubic yards) of solids. Water pollutants are not included because it is assumed that water will be used in the processing or wasted so that none enters surface or underground

FIGURE VIII-26

Waste Products - Oil Shale Mining, Transportation, Preparation

System	Efficiency (%)	Multiplier	Units	Air Pollutants: Particulates	NO_x	SO_x	Hydrocarbon	CO	Aldehydes	Solids	Land Req'd (acre)	Health: Deaths	Injuries	Man-Days Lost
Underground Room and Pillar Mining	65		ton/10^{12} Btu	.354	.076	.005	.008	.046	.0006	17.5	1.97	.0041	.189	NA
Kaiparowits Equivalent Output		275.98	ton/yr	97.7	21.0	1.4	2.2	12.7	.17	4830	544.0	1.13	52.2	--
Surface - Open Pit Mining	62		ton/10^{12} Btu	.013	.379	.028	.038	.231	.003	50,300	3.99	.0011	.054	NA
Kaiparowits Equivalent Output		289.34	ton/yr	3.76	110.	8.1	11.0	66.8	.87	1.46 x 10^7	570	.318	15.6	--
Transportation Conveyor	100		ton/10^{12} Btu	.481	0	0	0	0	0	0	.04	U	U	U
Kaiparowits Equivalent		282.66	ton/yr	136.	0	0	0	0	0	0	11.3	U	U	U
Transportation - Truck	100		ton/10^{12} Btu	.014	.404	.029	.04	.245	.003	0	.02	U	U	U
Kaiparowits Equivalent		282.66		4.0	114.	8.2	11.	69.4	.85	0	5.65	U	U	U
Preparation - Crushing	100		ton/10^{12} Btu	.84	0	0	0	0	0	1730	.08	U	U	U
Kaiparowits Equivalent		282.66	ton/yr	237.	0	0	0	0	0	4.89 x 10^5	22.6	U	U	U

NOTE
Table developed from Energy Alternatives, A Comparative Analysis, Univ. Okla., 1975, pp. 2-36 and -37.
Original data presented on basis of 10^{12} Btu inputs to each process.
Kaiparowits equivalent output converts original data to the equivalent of 3,000 MW output per year at the retort site, (8.97 x 10^{13} Btu/yr), after modification based on efficiency of process as noted in source material.
Water pollutants produced are not shown since it is assumed that waste waters would be retained at the site and not discharged to surface waters.

FIGURE VIII-27

Waste Products - Oil Shale Processing

Process	Efficiency (%)	Multiplier	Units	Air Pollutants						Solids	Land Required		Health		
				Particulates	NO_x	SO_x	Hydrocarbons	CO	Aldehydes		Fixed/ Increment	Acres	Deaths	Injuries	Man-Days Lost
Gas Combustion	53.1		ton/10^{12} Btu	4.0	35.5	30.6	12.3	0.04	0.3	1.08×10^5	1.78/0	1.78	0.0014	0.155	0.444
Kaiparowits Equivalent Output		168.9	ton/yr	676	6,000	5,170	2,080	6.8	51.0	1.82×10^7	301.0/0	301.0	0.0236	25.2	75.0
TOSCO II	66.7 50		ton/10^{12} Btu	0.2	12.9	37.4	12.2	0.01	0.1	1.08×10^5	1.78/0	1.78	0.0014	0.145	0.141
Kaiparowits Equivalent Output		134.5	ton/yr	26.9	1,730	5,030	1,640	1.3	13.0	1.45×10^7	239.0/0	239.0	0.188	19.5	19.0
Kaiparowits Equivalent Output		179.4	ton/yr	35.9	2,310	6,710	2,190	1.8	18.0	1.94×10^7	319.0/0	319.0	0.251	26.0	25.3
BuMines In Situ	53.1 45		ton/10^{12} Btu	6.5	7.5	264.0	160.0	11.3	0.13	0	1.41/.43	7.84	0.0036	0.571	0.097
Kaiparowits Equivalent Output		168.9	ton/yr	1,100	1,270	44600	27000	1,910	22.0	0	238.0/72.6	1320	0.608	96.4	16.4
Kaiparowits Equivalent Output		199.3	ton/yr	1,300	1,490	52600	31900	2,250	25.9	0	281.0/85.7	1560	0.718	114.0	19.3

NOTE
Table developed from Energy Alternatives, A Comparative Analysis, Univ. Okla., 1975, pp. 2-36 and -37.
Original data presented on basis of 10^{12} Btu inputs to each process.
Kaiparowits equivalent output converts original data to the equivalent of 3,000 MW output per year at the retort site, (8.97×10^{13} Btu/yr), after modification based on efficiency of process as noted in source material.
Water pollutants produced are not shown since it is assumed that waste waters would be retained at the site and not discharged to surface waters.

waters. Off-gases from the retorting are assumed to be used in upgrading and in providing power for the installation.

As shown in Figure VIII-28, water consumption during the production of shale oil having the same Btu equivalent as a 3,000 MW power plant would be between 3,850 and 7,610 acre-feet per year, depending on the mining and processing methods used.

Environmental impacts noted above would result from obtaining fuel in useable form (synthetic petroleum). If the synthetic petroleum products were to be converted into electricity, local environmental effects at the power plant would be much the same as for any other fossil-fueled power plant of the same size.

FIGURE VIII-28

Water Consumption for Shale Oil Production

Use Category	Water Consumption (acre-ft/yr)					
	50,000 bbl per day of shale oil, underground mining	100,000 bbl per day of shale oil, surface mining	50,000 bbl per day of shale oil, in situ processing	Water Consumption for Kaiparowits Equivalent Output: 8.97 x 10^{13} Btu/year		
				Underground Mining	Surface Mining	In situ Processing
Process requirements:						
Mining and crushing	370 - 510	730 -1,020	0	320 - 450	320 - 450	0
Retorting	580 - 730	1,170-1,460	0	510 - 640	510 - 640	0
Shale oil upgrading	1,460-2,190	2,920-4,380	1,460-2,220	1,280-1,920	1,280-1,920	1,280-1,940
Processed shale disposal	2,900-4,400	5,840-8,750	0	2.540-3,850	2,550-3,830	0
Power requirements	730 -1,020	1,460-2,040	730 -1,820	640 - 890	640 - 890	640 -1,590
Revegetation	0 - 700	0 - 700	0 - 700	0 - 610	0 - 310	0 - 610
Sanitary use	20 - 50	30 - 70	20 - 40	20 - 40	10 - 30	20 - 40
Sub-totals	6,060-9,600	12,150-18,420	2,210-4,780	5,300-8,400	5,320-8,060	1,930-4,180
Associated urban:						
Domestic use	670 - 910	1,140-1,530	720 - 840	590 - 800	500 - 670	630 - 740
Domestic power	70 - 90	110 - 150	70 - 80	60 - 80	50 - 70	60 - 70
Sub-totals	740 -1,000	1,250-1.680	790 - 920	650 - 880	550 - 740	690 - 800
Totals	6,800-10,600	13,400-20,100	3,000-5,700	5,950-9,270	5,860-8,790	2,620-4,990
Average values	8,700	16,800	4,400	7,610	7,350	3,850

NOTES:
Based on 178,000 bbl/10^{12} Btu, and 3,000 MW = 8.9694 x 10^{13} Btu/yr Kaiparowits equivalent = 43,741 bbl/day.

Source: Energy Alternatives: A Comparative Analysis (Univ. Okla., May 1975), p. 2-44.

bbl = 42-gallon barrel.

Tar sands

The United States has an estimated 30 billion barrels of oil (2 to 3 percent of the world's resource) in tar sands, with perhaps two-thirds of it, or more, located in Utah. Gilsonite, a high-grade tar sand, is mined in Utah and slurried through a pipe line to a refinery; products are used primarily for chemical feedstocks.

Tar sands consist usually of a bituminous fraction, often solid at normal temperatures, in pore spaces in sandstone or dolomite. A deposit containing 14 percent bitumen is considered rich; the usual range is between 9 and 16 percent.

Except for the gilsonite mentioned above, there is no commercial mining and processing of tar sands in the U.S. Some information is available from Canadian sources, describing tar sands occurring in different formations (Univ. Okla., 1975).

Present mining prospects call for strip mining thick beds under shallow overburden (with about 80 percent recovery) and separation of the bitumen with steam, hot water, and sodium hydroxide in separation tanks. In situ processing may prove to be favorable in extracting bitumen from deeper deposits. The bitumen must be upgraded by thermal breakdown or direct hydrogenation before it can be handled and refined as a synthetic crude oil (syncrude).

Based on scanty data, energy requirements for in situ processing probably run about 16 percent of the energy of the bitumen recovered. Processing on the surface requires about 0.5 percent of the energy content of the bitumen. This does not include the energy required to mine the tar sands.

Environmental effects have not been well established. The effects from strip mining would be much the same as strip mining for coal. The most significant potential discharges from the surface extraction processing would be the solid tailings, at least part of which might be put back into the mine. In

addition, there would be cooling water and blowdown streams, thermal discharges, and off-gases, which appear to be amenable to recovery or treatment so as to minimize effects on the environment.

Each barrel of bitumen is equivalent to 6.3×10^6 Btu. A processing plant able to produce the equivalent energy of a 3,000 MW generating plant must have an output of about 39,000 barrels per day (bbl/day). On the basis of 14 percent bitumen and 90 percent efficiency in processing, a plant producing 39,000 bbl/day would produce a little more than 55,000 cubic yards per day in tailings. Experience in Canada has shown that if the overburden were about as thick as the seam being mined, the strip mine feeding such a processing plant would have to move about 100,000 cubic yards of material per day. Auxiliary energy requirements would be about 19 MW. Water consumption has not been established.

Hydroelectric power

Between 1940 and 1971, the use of hydroelectric power generation declined from 30 percent to 15 percent of the installed electric generating capacity of the United States. The U.S. Department of the Interior (USDI) (Geothermal Leasing EIS, 1973) estimates that about 35 percent of the potential hydroelectric power that can be developed from an engineering standpoint has been developed in the lower 48 states (see Figure VIII-29).

About 42 percent of the potential hydroelectric power in the lower 48 states lies in the Pacific Coast states of Washington, Oregon, and California. About 38 percent of developed capacity in the lower 48 states is installed in the same states. Approximately 40 percent of the undeveloped capacity remains in the three states. However, other authors (Univ. Okla., 1975) would reduce the practical developable limit to about 75 percent of the USDI figures due to economic, environmental, and political constraints.

Development of hydroelectric power has not been as attractive to utilities as other forms of power generation, due to the increasing lack of good sites, local opposition to large dams and lakes, high capital costs involved, and long construction times (typically 5 years or more to build the dam).

Southern California utilities propose to construct 6,673 MW of hydroelectric capacity between 1972 and 1991 (State of California, June 1973), in addition to fossil-fueled and nuclear plants. The new capacity from hydroelectric development would amount to about 25 percent of the remaining available, based on USDI figures as modified (Univ. Okla., 1975). The proposals include about 3,600 MW of installed pumped storage peaking capacity.

Hydroelectric power is produced when water under pressure turns a turbine which spins a generator, after which the water is released. Since water is returned to the streams to continue through the hydrologic cycle, hydroelectric power uses a renewable resource and is not a drain on available fuel reserves.

FIGURE VIII-29

United States Hydroelectric Power Resources by Region

Region	Potential Power (10^3 MW)	Developed Capacity (10^3 MW)	Percent Developed
New England	4.8	1.5	31.3
Middle Atlantic	8.7	4.2	48.3
East North Central	2.5	0.9	36.0
West North Central	7.1	2.7	38.0
South Atlantic	14.8	5.3	35.8
East South Central	9.0	5.2	57.8
West South Central	5.2	1.9	36.5
Rocky Mountain	32.9	6.2	18.8
Pacific	62.2	23.9	38.4
Subtotal (lower 48 states)	147.2	51.8	35.2
Alaska	32.6	0.1	0.3
Hawaii	0.1	0.0	0.0
TOTAL	179.9	51.9	29.0

Source: Interior, 1973: Vol. I, p. IV-170.

In practice, hydroelectric power generation produces several environmental impacts. Typically, large dams up to 1,000 feet high are needed to impound water. The dams require large amounts of materials (earth and rock fill, steel, concrete) and take several years to construct. Dust and vehicle emissions are produced during construction; silt and erosion are likely to occur in the stream. Vegetation must be stripped from the reservoir area or inundated by rising waters; wildlife habitat is removed and wildlife is displaced or killed. Vegetation and wildlife replacing the originals are likely to be of different kinds. A reservoir acts as a trap for some kinds of water pollutants; consequently, water released from the reservoir may be substantially different from water entering the reservoir. In deep reservoirs, stratification occurs holding cold, low-oxygen waters near the bottom of the reservoir. Release of these waters has caused fish kills downstream. Dam construction can also have adverse effects on fish spawning, migration, and downstream habitat. Large bodies of water can cause minor local effects on weather. Large amounts of land are permanently removed from other uses. Changes in flow patterns from hydroelectric power generation can interfere with other uses of the water. Recreation resulting from the presence of a large lake is an economic attraction to the surrounding community, but may put pressure on the immediate ecosystem.

Hydroelectric power plants convert about 80 percent of the water power into electricity (about 2/3 for pumped storage). If a hydroelectric power plant were constructed to generate 3,000 MW of electricity using an effective head of 100 feet, an average flow of 44,300 cubic feet per second would be needed. If the effective head could be raised to 1,000 feet, the needed flow could be reduced to 4,430 cubic feet per second (3,200,000 acre-feet per year). Several installations would be needed to produce 3,000 MW of power.

Organic wastes

Power generation from organic and inorganic waste is an accomplished fact in Europe, where large volumes of combustible wastes are produced within a small collecting area. Increased prices of energy and recent attentions by the EPA and other government agencies have resulted in some serious studies, some pilot plant operations, and a few full-scale operations in the United States.

Urban dwellers typically produce about 10 pounds of trash and garbage per capita per day (Univ. Okla., 1975). The raw waste contains about 5,200 Btu/lb, less than lignite coal (6,000). However, after the glass, metal, and noncombustibles have been sorted out, the remaining trash usually has a heat value of about 8,000 Btu/lb.

At least five methods have been devised for converting municipal trash and garbage into oil and gas, and they have been developed to the pilot plant stage or beyond (Univ. Okla., 1975). However, burning the oil and gas produced to generate electricity would add the pollutants produced by the generating plant to the pollutants produced by the conversion process.

Direct burning for electrical generation can be done if boilers designed for coal firing with ash removal facilities are available or can be constructed. Two installations, at St. Louis, Missouri, and Wilmington, Delaware, are using prepared organic wastes to supplement coal and oil-fired boilers, respectively. Particulates and nitrogen oxides emissions are about the same as a coal-fired plant where a coal-fired plant uses organic wastes as a supplementary fuel; particulates and oxides of nitrogen are increased when organic wastes are added to an oil-fired plant. Oxides of sulfur are reduced; the sulfur content of organic waste is about 0.12 percent by weight, equivalent to bituminous coal with an 0.3 percent sulfur content. Electric power generation with organic waste making up some part of the fuel has about the same efficiency as a fossil-fueled plant, 35 to 38 percent.

Collection costs are roughly 80 percent of the costs of disposing of municipal wastes and garbage; this would not be affected by disposing of the organic wastes in a fossil-fueled electric generating plant. It could increase the cost by requiring the hauling of trash and garbage to a fewer number of sites over longer distances. The trash and garbage must be classified and pulverized before burning, including removal of metals, glass, and noncombustibles, part of which may be sold for salvage value. The costs of classifying and pulverizing (about \$4.00 per ton in the St. Louis installation) are greater than the value of the electricity generated (about \$3.15 per ton in the St. Louis installation), making the prospect unattractive for electric utilities.

There are about 7 million persons in Los Angeles County, California (1970 census). On the basis of 10 pounds of trash per capita per day, they produce about 70 million pounds of municipal wastes per day. The heat value of this waste, at 5,200 Btu/lb, would be 3.64×10^{10} Btu/day. A 3,000 MW electric generating plant at 37 percent efficiency would require an input of 6.64×10^{11} Btu/day. Thus the total amount of collected trash from all of Los Angeles County would provide about 5 1/2 percent of the heat value needed to operate a 3,000 MW fossil-fueled plant. This would rule out the transport of municipal trash over long distances; and California's air-pollution control regulations pertaining to oxides of nitrogen, in particular, would eliminate the possibility, at least for the near future, of constructing a waste-supplemented, fossil-fueled electric generating plant within practical transport distance.

Coal gasification

Coal gasification - that is, the manufacture of a burnable gas, usually methane, from coal - is an old process receiving new attention. The production of "carburetted hydrogen gas" from the coking process made coal gas available to many Eastern U.S. cities before cross-country natural gas pipelines were built. Modern processes, some still in the laboratory and pilot plant stages, can produce a clean-burning, low-sulfur fuel having heat values ranging from 100 (very low) to 1,050 (in the range of natural gas) Btu per standard cubic foot (Btu/scf). Solid wastes, air pollutants, and water pollutants are produced wherever the coal is gasified. Water is consumed in the process.

Western Gasification Company (WESCO) proposes to construct four 250×10^6 cubic feet per day (ft^3/day) coal gasification batteries at a site southwest of Farmington, New Mexico, as set forth in a Final Environmental Impact Statement entitled Western Gasification Company (WESCO) Coal Gasification Project and Expansion of Navajo Mine by Utah International Inc., New Mexico (USDI, Bureau of Reclamation, 1976). The conversion of coal to gas would be about 64.8 percent efficient and would consume about 7,678 acre-feet per year of water in producing 250 million cubic feet per day of gas having a heat content of about 980 Btu/scf. Air pollutants produced would be a function of the coal used; each of the WESCO 250×10^6 ft^3 batteries is expected to produce about 3,600 tons/yr of sulfur dioxide, 6,400 tons/yr of nitrogen oxides, 7,800 tons/yr hydrocarbons, 625 tons/yr of particulates, carbon dioxide and carbon monoxide, and a small quantity of hydrogen sulfide.

While electric generating plants can be constructed to use gases of low thermal value, the gasification process efficiency of even low-Btu gases is about 75 percent, and water consumption may be higher (Univ. Okla., 1974). Therefore, the discussion below is based on the WESCO proposal as being indicative of much of the present state of commercial coal gasification.

The gasification of coal in Utah for use in one or more electric generating plants elsewhere, perhaps in California, is a possible alternative to the construction of a 3,000 MW coal-fired electric generating plant on the Kaiparowits Plateau. The alternative has the advantages of being able to generate power closer to its points of use, of being able to bury gas pipelines with minimal effect on desert landscapes and wildlife, and of being able to divert some of the gas produced to direct home and commercial heating without going through the process of converting into electricity.

However, at 65 percent efficiency, a coal gasification plant sufficient to power a 3,000 MW generating station would use nearly 14 million tons of coal per year instead of the 9 million tons per year projected for use in the proposed Kaiparowits coal-fired plant. The water requirements for the coal gasification plant would be about 16,700 acre-feet per year; this would be in addition to the cooling water required for a 3,000 MW gas-fired generating station, about the same as would be required for a coal-fired one. If the gas-fired power plant were to be built elsewhere, the cooling water requirement would come out of the local supply.

At a gasification plant, precautions would have to be taken to prevent the entrance of polluted wastewaters into surface or ground waters. A WESCO-type coal gasification plant sufficiently large to furnish fuel for a 3,000 MW power plant might also produce, depending on constituents in the coal, about 85 percent of the ash, 8 percent of the NO_x, about 22 percent of the particulates, and about 32 percent of the SO_2 as would be produced by the proposed Kaiparowits coal-fired power plant with stack emission controls in operation.

Among commercial advantages of a coal-gasification plant would be salable quantities of by-products such as sulfur, phenols, naphtha, tar oils, tar, and anhydrous ammonia.

Detailed costs have not been calculated; however, it is reasonable to assume that a coal gasification plant and a pipe line in addition to the present power plant and as a substitute for part of the transmission system would result in a more expensive project. The alternative appears to be technologically feasible.

Nuclear power

All utilities participating in the Kaiparowits project are also participants in various nuclear power plant projects:

Southern California Edison

San Onofre I: 344 MW (80% of 430); 1968
" " II and III; 1,824 MW (80% of 2,280)
approx. 1980

San Diego Gas & Electric

San Onofre I, 86 MW (20% of 430 MW); 1968
" " II, and III; 456 MW (20% of 2,280 MW)
approx. 1980

Arizona Public Service

Arizona Nuclear I; 357 MW (28.1% of 1270 MW); 1981
" " II; 357 MW (28.1% of 1270 MW); 1983
" " III; 357 MW (28.1% of 1270 MW); 1984

The decision to use coal rather than nuclear power depends upon an evaluation of various economic, technical and environmental factors and the time at which evaluation is made. In this case, the choice was dictated by availability of coal, participating utilities' policies to reach what they consider a proper balance between nuclear and fossil fuels, and their uncertainties in scheduling nuclear generating stations. However, nuclear power plants are a definite alternative to coal-fired plants.

Three major types of nuclear reactors are now being given consideration for commercial power production: the light-water reactor, the high-temperature gas reactor, and the liquid-metal fast breeder reactor (Univ. Okla., 1975). Each has advantages; each has drawbacks.

U.S. uranium resources are limited. The Atomic Energy Commission (AEC) has projected a nuclear generating capacity of 250,000 MW by 1985, requiring the use of 50,000 tons of uraniun oxide per year. At this rate, the AEC estimated reserves of 520,000 pounds of U_3O_8 extractable at costs under $15 per pound would be exhausted in slightly more than 10 years in light water reactors.

Light-water reactors are being manufactured and are in commercial production. Their thermal efficiency is about 32 percent, compared to about 40 percent for a new coal-fired power plant, requiring the dissipation of about 25 percent more heat for the same production of electricity.

The high-temperature gas reactor uses helium as a coolant and transfer fluid, and a mixture of thorium dioxide, enriched U-235, and reprocessed U-233 as a fuel. One 40 MW plant began operation in 1966, and another was due to begin operations in 1975. The volume of radioactive wastes produced by the high temperature gas reactor is about 70 percent of the volume produced by a light-water reactor of similar size.

The liquid-metal fast breeder reactor has the potential of creating fuel (Plutonium-239) which can be used in other reactors. It would also operate at higher temperatures than either the light water or high-temperature gas reactors, allowing a thermal efficiency of about 41 percent. It requires safe handling of large amounts of plutonium, one of the most toxic substances known to man, and it would use liquid sodium, a highly reactive element, as a coolant. The high operating temperature poses its own problems; at the Emico Fermi nuclear power plant, near Detroit, Michigan, part of the core melted after a coolant passage was blocked.

Nuclear power plants, unlike fossil fuel plants, do not emit products of combustion such as particulates, sulfur oxides, and nitrogen oxides. However, they do produce radioactive emissions which must be strictly limited if adverse effects to health of humans and other biota are to be avoided.

Due to generally lower thermal efficiencies, nuclear power plants are likely to produce more waste heat - hence, use more cooling water - than conventional coal-fired power plants of the same power output capacity. With cooling towers or cooling pond haze, fog, cloud, and ice formation would still occur during periods of sub-freezing temperatures.

Operation of nuclear plants poses some risk of accidents. Accidents could occur at several places in the chain between the mining of ores and the disposal of radioactive wastes (Univ. Okla., 1975). Some of the areas for potential accidents are tabulated below:

Uranium enrichment plant:

- fire
- explosion
- criticality

Fuel fabrication:

- rupture of a hot uranium fluoride (UF_6) cylinder, releasing uranium and hydrogen fluoride
- criticality accident
- furnace explosion
- fire in fabricating fuel for liquid-metal fast breeder reactor

Reactors:

- core meltdown
- plumbing leaks, radioactive and non-radioactive liquids and gas
- sodium leaks (liquid-metal fast breeder reactor)
- refueling accidents

Fuel reprocessing:

- criticality of used fuel
- fuel element rupture
- leakage of radioactive liquid
- solvent fire
- explosive rupture of a process vessel
- catastrophic failure of a krypton (Kr-85) storage vessel (breeder reactor)
- acts of God (floods, tornadoes, earthquakes)

Waste management:

- handling accident
- cooling system failure

Transportation:

- accidental criticality
- breach of high-level waste container

While any of the above accidents are possible (and some have happened), the Atomic Energy Commission (now the Energy Research and Development Administration, as noted in Univ. Okla., 1975) holds that through proper precautions the possible accidents can be made highly improbable or can be effectively contained so as to minimize damage, usually to little more than background radiation at the site boundary. The 1973 California Power Plant Siting Plan (State of Calif., the Resources Agency, June 1973) concludes that nuclear plants will be needed to produce half of the electrical power needed to meet the demand during the 20-year period. Other information has been assembled by the authors of a report to the Oregon Energy Council (Schatz, 1975) who flatly conclude (p. 121) that "the benefits from nuclear fission could be accessed by other means, and the risks, which are enormous, are unacceptable."

High level radioactive wastes presently are being stored underground in solid, concentrated form in containers. Permanent disposal of radioactive wastes is a problem which has not yet been solved.

Additional impacts associated with nuclear power plants are discussed in the "Final Environmental Statement for the San Onofre Nuclear Generating Station Units 2 and 3" (U.S. Atomic Energy Commission, 1973) and the "Draft Environmental Statement for the Bellefonte Nuclear Plant" (Tennessee Valley Authority, 1973).

Geothermal

Companies participating in the Kaiparowits project are investigating the potential of geothermal energy sources to serve needs in their respective market areas.

Geothermal energy exploration and development by San Diego Gas & Electric Company (SDG&E) began in January, 1971. Wells were drilled in Imperial Valley, California and flow tests were conducted to define extent and potential of geothermal resources. Subsequently, SDG&E engaged in testing equipment and overcoming scaling problems caused by mineral-laden geothermal fluid. Since there is presently no commercially-proven equipment for recovering heat energy of geothermal brines, they propose construction of a geothermal test facility in 1975. Assuming the most optimistic results with the test facility, the program could lead to an installed capacity of between 50 and 75 megawatts by 1981.

Southern California Edison (SCE) entered into an agreement September 6, 1972 with Southern Pacific Land Company and Phillips Petroleum Company to investigate Imperial Valley geothermal brines to ascertain the feasibility of generating electricity. Initial field efforts commenced during the second quarter of 1973 and were directed to establishing a reliable well production and injection system with emphasis on resolution and/or minimization of scale and corrosion problems. Power generation field testing will follow during the second quarter of 1975. Research work is expected to be completed by early 1976 resulting in recommendations for possible future pilot or demonstration geothermal brine generating units.

In early 1974, Southern California Edison signed a letter of intent with Magma Energy, Inc. for research and development of a binary cycle geothermal power plant in Mono County near Mammoth Lakes, California. The 10 MW demonstration unit will be built on property owned by Magma and, subsequent to successful performance testing by January, 1978, SCE will consider purchase of the plant.

Arizona Public Service Company (APS) and the Salt River Project (SRP) joined with Tucson Gas & Electric to partially fund exploratory drillings in Chandler, Arizona. APS and SRP are members of the Electric Power Research Institute which is doing work in the field of geothermal energy.

Lands under consideration for geothermal leasing are presently subject to use for grazing, forestry, mining and other mineral production, fish and wildlife habitat, outdoor recreation, and watersheds.

Development of geothermal resources entails construction of access roads and well sites, drilling and testing of wells, conveyance of steam or hot water over short distances to electric power plants and by-product processing plants, construction of electric power plants, by-products facilities, electrical transmission lines, and facilities for disposing of waste liquids.

Land would be pre-empted or restricted from uses such as wildlife habitat, recreational use, grazing, etc. Terrain would be modified through construction of roads, wells, pipelines, and industrial facilities. Noise and noxious gas emissions could pose problems during testing and production. Possible adverse effects include land subsidence due to removal of fluids and increased seismicity due to reinjection of fluid wastes into producing zones.

Additional impacts associated with geothermal energy are discussed in the final environmental impact statement of the "Geothermal Leasing Program" prepared by the U.S. Department of the Interior, 1973. It is also discussed in Bureau of Land Management's "Energy Alternatives and Their Related Impacts", 1975.

There are indications that few geothermal sites in the world can sustain the production of power which would be produced by the Kaiparowits project. Estimates of available geothermal energy in the United States over the next 50 years vary considerably. Some authors will hold that about 1,000 to 1,200 MW of electricity can be generated from known recoverable reserves, and

estimates of electrical production from reserves recoverable at somewhat higher cost range from 3,000 to 8,000 MW for the entire United States. Other authors make higher estimates. A good basic discussion of geothermal energy is presented in "Energy Alternatives: A Comparative Analysis," University of Oklahoma, 1975.

Solar energy

Several applications for use of solar energy are under development, e.g., solar water heating, swimming pool heating, home heating, solar baking, solar distillation, solar power plants, solar furnaces, solar pumps and turbines.

Among the potential applications of solar energy, residential heating and cooling has the greatest possiblity of success at the present time. Solar space heating and cooling is not as advanced as solar water heating which has been used to some extent in southern Florida. However, there is an increased trend toward solar heating and cooling in many new homes and buildings in the West.

Another potential application of solar energy is use of thermal gradients to extract solar energy stored in surface layers of the ocean. The summer sun melts polar ice and the cold water moves to the depths of the ocean and flows toward the equator. Above the cold deep water, surface layers in the tropics remain at a temperature above 80^{o} F. This difference in water temperature can be used to generate electricity.

At the University of Massachusetts, Amherst, William Heronemus and his colleagues are preparing preliminary designs for a submerged power plant in the Gulf Stream. One proposed site is the western edge of the Gulf Stream about 16 miles from Miami. The concept now being considered is a modular design with six turbines in each of two hulls, hooked together. The station would generate about 400 MW of electricity.

Other potential power sources ultimately based on solar power are being considered or experimented with, including windmills and wind-powered generators, direct conversion of solar radiation to electricity, and the conversion of organic matter to fuels and electricity. Some of these methods are very old (windmills), some are used only on a small scale (photovoltaic cells), and others

are in use in modified form (the burning of biomass, such as wood, for heat and power). None have been scaled upward to the degree necessary for present commercial electric power generation.

Solar power has great potential for supplying at least part of the projected demand. It is an ideal approach because it uses an energy source that is inexhaustible and emission free. Development of this energy source has been given little attention and proven technology for large-scale commercial application is limited. A proposal has been made (Schatz, 1975) which would combine residential unit solar heating with geothermal and hydroelectric power production and energy conservation measures to achieve Oregon's energy demands by the year 2000. Implementation of such a proposal within the Kaiparowits market area would require additional generating capacity before the proposal could become fully operative.

Therefore, it is questionable if solar energy would be a feasible alternative in the immediate future for meeting the project objective of generating 3,000 MW of electricity.

Primary impacts from use of solar energy would be negligible. However, a beneficial secondary impact could be a reduction in conventional energy forcast demands, which in turn could possibly reduce need for new thermal generating facilities.

Investments in energy conservation services

Projected growth based on past performance

During the past 3 years attention has been given to energy conservation as a means of either delaying or regulating construction of new electrical generating plants. This concern has been discussed in the Ford Foundation Energy Policy Project Study and the American Association for the Advancement of Science publication "Energy: Use, Conservation, and Supply." Other discussions have been given in Energy Alternatives: A Comparative Analysis (University of Oklahoma, 1975), and California's Electricity Quandary: III. Slowing the Growth Rate (Doctor, et al., 1972).

Before consequences of energy conservation can be assessed, projected growth based on historic growth of electric generation must be identified.

Figure VIII-30 identifies the rate of annual growth in electrical generation for each of the participants and the number of times electrical generation could grow based on national trends (Freeman, 1974).

FIGURE VIII-30

Comparisons of Participants' Projected Annual Rate of Growth and the Growth Increase for Selected Years as Compared to the National Average

	Annual Rate of Growth (%)			Number of Times Electrical Generation Could Grow by:	
	1975-1979	1980-1985	1986-2000	1985	and 2000
Southern California Edison[a]	4.7	4.7	4.7	1.6	3.2
Arizona Public Service[a]	7.3	5.9	5.9	1.9	4.4
San Diego Gas & Elec[a]	8.4	6.5	6.5	2.0	5.2
Average of Participants	6.8	6.0	6.0	1.8	4.4
National[b]	6.0	6.0	5.1	1.8	3.8

[a] Developed from FEA Report in Appendix I-1
[b] Developed from Ford Foundation's Energy Policy Project (Freeman, 1974)

According to past history, projected growth of electrical energy generation from a national standpoint, is based on the premise that the number of households will increase 50 percent and industrial use will increase by 25 percent by the year 2000, based on the U.S. Census Bureau 1972 Series E population projections (Freeman, 1974). It is also assumed that gross national product will increase 3.6 percent per year until 1985 and 3.3 percent per year until the year 2000.

For the growth of electrical energy generation to proceed as it has in the past, it would be necessary for a Federal Government committment towards a strong research and development effort. This effort would be essential to support the growth of new energy supplies, more productive coal mining techniques and nuclear breeder reactors. Rapid growth of nuclear power would be essential to maintain growth based on historical projection. Unsolved environmental problems such as air pollution, reclamation of surface-mined lands and uncertain nuclear risks would have to be accepted with the hope they would be solved in a reasonable length of time.

It is doubtful that the present rate of electrical energy generation growth could be maintained as limitations in skilled labor, heavy equipment, available water supply and available financing would develop (Freeman, 1974). The problems with financing and water supplies would require federal authority and financing to help industry develop energy. The Energy Policy Project of the Ford Foundation does not agree that governmental policies and actions necessary to maintain electric growth are desirable. Also, energy self-sufficiency on a national level by 1985 would not be possible if electrical energy growth maintained its present rate.

Energy conservation by application of technology

One means of offsetting problems created by unchecked electrical energy growth would be to use electrical energy more efficiently by application of technology that is either now available or soon will be. Such applications would be:

(1) Remodel old, inefficient electric generators and peaking generators to make them more efficient. Ironically, pollution control equipment reduces efficiency of steam generator plants.

(2) Promote electric generation as a by-product of steam-raising operations, such as paper and vulcanizing industries. This would free these operations from the need to buy electricity, and might provide surplus electricity to be used elsewhere.

(3) Promote recycling, which for aluminum, requires only 2 to 5 percent of the energy which is needed for primary processing (Univ. Okla., 1975). Improving present practices of recycling metals and glass could result in 10 to 15 percent energy savings over the short term (Freeman, 1974).

(4) Maintain electrical equipment to reduce energy loss, and improve productivity by reducing idle time.

(5) Curtail purchase of additional electrical equipment and appliances that are not necessary.

(6) Increase research, development, and marketing of more efficient electrical equipment and alternate means of achieving objectives. These would include more efficient production and transmission of electricity, development and use of solar energy and battery-operated equipment, and substitution of electrical heat pumps, resembling refrigerators operating in reverse, for electrical resistance heating.

(7) Utilize environmental monitoring and control systems to more efficiently regulate temperature and humidity, especially in large buildings.

(8) Increase insulation to optimum levels in buildings, including homes, and heated and refrigerated storage and transfer systems.

(9) Improve ventilation systems in buildings, and remove air pollutants at their source rather than depending on dilution by over-ventilation.

(10) Promote common district heating and reuse of steam rejected by nearby generating stations.

(11) Require minimum performance standards for appliances, equipment, and housing.

(12) Require lables on appliances, which state the level of efficiency.

(13) Reschedule working times, especially of major consumers, to avoid peak load times.

(14) Curtail electrical-use promotions.

(15) Provide education on how to use electricity efficiently and avoid unnecessary and wasteful use. Publicize cost/efficiency ratios of marketed appliances, and provide information regarding energy shortages and values of conservation.

(16) Provide economic, tax, and award incentives for conservation of energy.

(17) Replace promotional rates (the more one uses the less one pays per unit of consumption) with conservation rates (the more one uses the more one pays per unit of consumption).

The application of technology would require governmental actions to overcome institutional barriers to technical innovation and to promote economically optimal designs in the building industry, more efficient industrial products, and materials recycling.

Basic benefits of this approach would be that the need for nuclear power would be 80 percent of that identified under the projected growth based on

past performance. Investments by the year 2000 would be approximately 300 billion dollars less than that estimated for uncontrolled projected growth. This would alleviate the possibility of a tight money situation since the investment for new power plants would be 20 percent of total income which is similar to the past few years. This approach would allow the United States to reduce fuel imports by one-half for the period of 1985 to 2000.

Application of this approach could mean that by the year 1985 the gross national product (GNP) would be 1.5 percent less than present projected estimates, and 4 percent less in the year 2000. However, the GNP for the year 2000 would still be twice 1973 level. Potential for employment under this approach is estimated to be 1.5 percent higher than that estimated for projected growth based on past performance. This increase in employment would be due to higher price for energy which would slightly modify the productive process and substitute labor for energy (Freeman, 1974).

The consumption of energy should not be controlled solely by increasing the consumptive costs or costs of fuel. Presently in the United States 60 percent of the families (poor and lower middle income) consume only 31 percent of the energy, whereas forty percent of the families (upper middle income and well-off) consume 69 percent of the energy (Freeman, 1974). Controlling energy consumption by raising costs would not reduce the consumption appreciably but could result in forcing those families on marginal incomes into some form of welfare thus raising social costs.

Zero energy growth

Another alternative to coping with uncontrolled growth of electrical energy would be for the nation to reach zero energy growth by the year 2000. This approach would have the same energy saving measures as those listed in the previous energy conservation section but greater emphasis would be placed on the

efficiency and durability of electrical goods. More emphasis would be placed on services and less on manufacturing. Approximately 2 percent of the GNP would be diverted through higher energy taxes to enhance quality of life.

Zero energy growth would recognize the following items:

(1) Limiting regional development.

(2) Pollution reduction.

(3) Avoiding catastrophic accidents in energy supply systems.

(4) World development considerations.

(5) Avoiding climatic alterations.

(6) Decentralizing technology.

(7) Changing attitudes and social values.

The GNP for the years 1985 and 2000 would be the same as that identified in the previous energy conservation section. However, because of emphasis on services, employment in the year 2000 would be 7 percent greater than that estimated for uncontrolled energy growth. Zero energy growth would reduce the need for importation of fossil fuels even more than the application of technology during the period of 1985 to 2000.

At the present time there is considerable concern over the build-up of CO_2 in the atmosphere from the burning of fossil fuels. Some scientists believe that additional CO_2 in the atmosphere could cause drought in lands near the equator and lead to another ice age due to global cooling. Other scientists fear that increased surface heating would occur due to increased CO_2 content. If this happened the icecaps would melt causing flooding of low lands and disruption of agriculture.

Regardless of which theory is correct man's way of life would be drastically changed. Present estimates indicate that if the current rate of fossil fuel burning continues, the CO_2 content in the atmosphere would increase by 20 to 25 percent by the year 2000.

Figure VIII-31 indicates the number of times electrical energy output could increase for the years 1985 and 2000, based on the present output for the nation compared to the participants' projections. The national figures contain a breakdown for projected residential, commercial and industrial electrical energy growth.

Before any type of conservation measures can be implemented, whether by the application of technology or zero energy growth, there must be a national energy policy enacted by the Congress and actively adopted by all government agencies to carry out such a policy. This would require coordinated efforts in applying tax benefits for concerted use of energy saving techniques, changes in pricing regulations, and regional planning for the benefit of national needs.

Based on present projections, construction of the Kaiparowits coal-fired generating plant could not be replaced by adoption of energy conservation measures. As presently proposed the power plant would begin generating electricity by 1981. If a national energy policy had already been adopted and was totally in effect now the proposed Kaiparowits generating plant would not need to go into operation until 1991. However, if a national energy policy was adopted in the near future and did not become totally effective until 1980, the Kaiparowits generating plant would have to go into operation by 1986.

FIGURE VIII-31

Comparison of Average Electrical Energy Growth for the Participants and National Average If Conservation Measures Are Implemented

	Number of Times Electrical Energy Could Increase by the Following Years as Based on Present Output	
Projected Growth Based on Past Performance	1985	2000
Nationally		
Residential[a]	1.8	2.9
Commercial[a]	1.5	2.9
Industrial[a]	2.0	4.9
National Average[a]	1.8	3.8
Participants' Average[b]	1.8	4.4
Energy Conservation by Application of Technology		
Nationally		
Residential[a]	1.2	1.8
Commercial[a]	1.2	1.6
Industrial[a]	1.1	1.7
National Average[a]	1.2	1.7
Participants' Average[c]	1.2	2.0
Zero Energy Growth		
Residential[a]	1.2	1.5
Commercial[a]	1.3	1.8
Industrial[a]	1.1	1.9
National Average[a]	1.2	1.7
Participants' Average[c]	1.2	2.0

[a] Developed from Ford Foundation Energy Policy Project.
[b] Developed from FEA Report in Appendix I-1
[c] Assumption made that Participants' projection would react proportionally with the nation.

Advanced generation and transmission systems

A variety of advanced concepts in central station, base-load generation and transmission are being developed. Some are closer than others to the point of economic feasibility. Some are of major significance and others represent modest improvements in efficiency.

Figure VIII-32 lists the most promising central station and transmission techniques along with relative significance and year of availability. None of these has reached a point of development where the need for Kaiparowits' 3,000 megawatts may be affected. Relative significance of a concept depends upon its potential for satisfying electric energy demand.

None of these advanced generation and transmission systems would be available soon enough to either offset or be incorporated in the Kaiparowits generating station, even if the project were delayed 2 to 3 years.

FIGURE VIII-32

Promising Advanced Generation and Transmission Systems

Concept	Potential significance	Year of availability as an economically-feasible option
Fusion	Major	after 2000
Breeder fission	Major	after 1990
Central station solar:		
Solar thermal	Major	after 1990
Photovoltaic	Moderate-Major	1985-1990
Bio-conversion	Minor	Possibly never in Southwest due to lack of water
Wind	Moderate	after 1985
Magnetohydro-dynamics	Moderate	1990
Large fuel cells	Moderate	1990-2000
Batteries	Moderate	1985
Nuclear reactor Gas turbine (possible elimination of most water requirements in gas cooled reactors at some decrease in thermal efficiency)	Major	1990
High voltage dc transmission	Major*	1980
SF_6 insulation systems	Major*	1980
Superconduction or near-super-conduction cables	Major*	1980
Ultra high voltage transmission	Major*	1980
Underwater transmission	Major*	1980

*Significance of advances in transmission technology lies in the fact that such advances mitigate siting problems by making possible greater separation between points of generation and consumption.

DELAY OR DENIAL OF PROPOSED ACTIONS

Moratorium on proposal until regional energy planning completed

The moratorium alternative assumes that the Secretary of the Interior, in accordance with the National Environmental Policy Act, can delay by moratorium any federal action under his jurisdiction related to development of energy resources.

A 1972 report outlined responsibility of the Federal Government in the Southwest Energy Study Area as follows:

> "The United States Government owns or holds in trust the vast majority of the land and the coal in the Colorado River Basin. The resulting responsibilities of ownership and trusteeship require the development of the land and the underlying coal resources be undertaken in keeping with prudent governmental responsibilities for environmental management. In the interest of all of the public, every governmental action must recognize the environmental effects, avoid unacceptable damages, and minimize losses". (Southwest Energy Study, Draft April 1972.)

On May 27, 1971, Secretary of the Interior Rogers C. B. Morton established the Southwest Energy Study with these objectives:

1. To assess electrical energy need in the Southwest and adjoining areas east of the Colorado River Basin for the next 20 years.

2. To determine: (a) the practicality of fulfilling the energy needs of the Southwest and adjoining areas using Colorado River Basin coal deposits; (b) the economic needs and prospects of the Colorado River Basin as affected by the development of the coal deposits; (c) the impact on cultural, social, and aesthetic factors resulting from development of Colorado River Basin coal; (d) the overall environmental impacts of development of coal resources.

3. To analyze alternatives for providing power to the Southwest and adjoining areas.

4. To study the environmental impact of long-term coal and power development within the Colorado Basin and adjoining areas.

5. To determine environmental tolerances of the Colorado River Basin for impacts involved in large scale, long-term generation of electric power. (Southwest

Energy Study, 1972, pages 1-5 to 1-6.)

To date, this study has been the most comprehensive attempt of regional energy planning. The Kaiparowits proposal was an integral part of the study and was considered in the context of the regional overview throughout the analysis.

While needs for regional energy planning are well recognized, no more comprehensive attempts beyond the scope of the Southwest Energy Study have been made. Nonetheless, relative merits and liabilities of a moratorium must be considered, in relation to the environmental impact. The primary rationale to impose a moratorium would be based on the anticipated potential of avoiding adverse cumulative regional impacts (caused by successive energy projects), which would outweigh the liabilities created by a moratorium.

A prerequisite to any moratorium would be assurance of cooperation with state and local governmental entities to support such a moratorium. Without such cooperation, a unilateral action by the Federal Government could be extremely detrimental to the long-term demand for close federal, state and local cooperation and coordination.

A moratorium generally appears to offer the possibility of realizing more environmental benefits over a period of time. Creation of regional goals, standards, guidelines and other needed policies to account for all interests involved would be another long-term benefit. However, none of these can go into effect without a national energy policy.

Effects of delay

Rising prices and government actions (e.g. rate restructuring or mandatory conservation) could reduce the rate of growth of demand for electric power. The date at which Kaiparowits' generating capacity would be required could be postponed.

Delay could also allow time for substantial refinements in scrubber technology and development of environmentally preferable generating technologies. However, utilities believe such technological improvements are not likely to become feasible in the near future. As discussed in the section on Investment in Energy Conservation Services of this chapter, a delay of 5 years could be imposed without undue hardship to society, if regional goals, standards and guidelines were developed immediately. However, Kaiparowits could replace 3,000 megawatts of oil fired generati capacity, presently requiring 80,000 barrels of oil per day.

The proposed actions might be delayed for from one to several years beyond the participants' schedule, for one or more of the following reasons: (1) litigation concerning proposed actions, (2) a moratorium imposed to provide time for further study of cumulative consequences of the proposed action and other possible projects in the region, (3) a moratorium to provide time for monitoring and studies to better assess the present environment and effects of existing generating stations and mining in the region, (4) rising prices which might result in hesitation by the participants, and (5) government actions such as rate restructuring or mandatory conservatior

The utilities believe that, unless demand growth rate is far less than is now projected, new technologies could not substitute for the proposed project as planned. If the Kaiparowits project was deferred and growth in demand occurred in accordance with the utilities' estimate, reserve generating capacity would fall below what is considered necessary to provide adequate system reliability. Figure VIII-33 indicates forecast reserve margins in the event the Kaiparowits schedule were delayed for 1 year, 2 years, or 3 years. These figures assume that demand will approximate the utilities' current forecasts.

FIGURE VIII-33

Reserve Margins

Arizona Public Service (18 percent of Kaiparowits output)

Year	No Delay (%)	1 Yr Delay[b] (%)	2 Yr Delay[b] (%)	3 Yr Delay[b] (%)
1981	12.3	8.2	8.2	8.2
1982	20.6	16.8	13.0	13.0
1983	19.9	16.4	12.8	9.2
1984	25.0	21.7	18.4	15.0
1985	24.3	24.3	21.2	17.6

San Diego Gas & Electric (23.4 percent of Kaiparowits output)

Year	No Delay (%)	1 Yr Delay[b] (%)	2 Yr Delay[b] (%)	3 Yr Delay[b] (%)
1980	11.5	11.5	11.5	11.5
1981	14.5	7.4	7.4	7.4
1982	23.7	17.0	10.2	10.2
1983	29.6	23.1	16.7	10.3
1984	28.9	22.8	16.7	10.6
1985	36.4	36.4	30.6	24.8

Southern California Edison (40 percent of Kaiparowits output)

Year	No Delay (%)	1 Yr Delay[b] (%)	2 Yr Delay[b] (%)	3 Yr Delay[b] (%)
1981	17.0	14.9	14.9	14.9
1982	20.8	18.8	16.9	16.9
1983	21.4	19.5	17.7	15.8
1984	19.1	17.3	15.6	13.8
1985	17.2	17.2	15.5	13.8

[a]Margins as percent of APS load forecast minus Salt River Project territorial.

[b]Assumes all units are delayed from their scheduled operating dates.

A 15 percent reserve margin is a partial indication that a system has adequate reserves. Figure VIII-33 suggests that a 15 percent reserve margin could be maintained if Kaiparowits were delayed up to 2 years, provided other facilities were not delayed and there were power transfers among Kaiparowits participants. Delay of the Kaiparowits project would, in the utilities view, lead to insufficient reserve margin to provide adequate system reliability. The Federal Energy Administration was not provided with sufficient data for them to either agree or disagree that delay would lower system reliability below an acceptable level (See FEA report in Appendix I-1).

A potential benefit of delay would be additional time for regional planning, whether or not this were the reason for delay. Because of the analysis devoted to the Kaiparowits project in this impact statement and in the Southwest Energy Study, further regional planning studies may not affect conclusions regarding the project's location, even though such a study might affect decisions concerning the location of subsequent projects. Delay might also provide additional time for monitoring, environmental studies, and observation of socioeconomic trends in the market and impact areas.

In general, very little change in the present physical environment of the Kaiparowits Plateau and transmission system areas would be expected to occur. Recreational and socioeconomic trends may also remain much the same, that is, small increases in recreation, seasonal variation in unemployment in Kane and Garfield counties, and declining population in Page, Arizona. However, these estimates are based on assumptions that no significant economic or other influences would occur to influence these trends, and that delay would last only a few years.

These effects, which could result from delay of the proposed project, would include both beneficial and adverse aspects. Therefore, they would need to be considere in any decision to impose a moratorium. Potential technologic improvements, comprehensive regional planning, and monitoring and analysis of environmental and

socioeconomic trends could have mitigating effects because adverse impacts of the proposed project, and perhaps those of other potential projects, could be reduced. However, this would happen only if the above events actually occurred, that is, that new methods would result in fewer or reduced impacts, and that regional planning and monitoring were initiated, proved useful, and the results utilized.

An adverse effect of the delay would be that more oil would be burned in oil-fired generators, the amount varying according to time of delay. This is based on the participants' assumption that Kaiparowits would replace some oil-fired facilitie

Unemployment in the region might remain at its present level, increase if future events are not favorable for employment, or decrease if future events become more favorable or if many of the unemployed leave the area. In the latter case, however, the unemployed would simply be moving to other areas where they might or might not become unemployed.

Since growing energy demands can be met through the economically and technologically proven practices of building another fossil fueled plant and opening another coal mine, little incentive exists for industry or government to aggressively pursue programs or systems potentially more efficient and environmentally sound but less well proven. Therefore, any shortage of electrical energy resulting from delay of the project could have a long term beneficial impact by providing stimulus and incentive for implementation of improved systems.

The possible effects of delay involve many variables, several of which cannot be accurately predicted. These include developments in technology, regional and national economic trends, availability of oil and gas both for electric generation and automotive use, government decisions, and whether or not regional planning and studies would be initiated and prove useful. Therefore, the effects of delay cannot be accurately predicted in terms of quantity.

Denial of proposed action

Effects on participants

Introduction

The preceding section discussed effects of delay. Denial of the proposed action would extend those effects and, according to the participants, would require that more oil be burned and would further reduce the companies' systems reliability by not meeting necessary reserve margins.

The participants were asked how they would provide substitute generating capacity, including whether they would add to existing stations or sites or build new plants, in the event that Kaiparowits were denied or delayed indefinitely. The following is a summary of their responses:

Southern California Edison

Increased amounts of oil-fired combined cycle or combustion turbine units would be installed in the 1981-1983 time frame. Two reasons were given for this choice: (1) Lead time for nuclear and coal-fired generation is 8 years or more, and such stations therefore could not be built in time to meet anticipated demand; and (2) 452 MW of combined cycle capacity is scheduled for operation in 1984, and this might be brought into line by 1981 if construction could be accelerated.

SCE stated, however, that additional units would be required by 1983-1984, because the 452 MW would not meet the expected need for 1200 MW, as planned in the Kaiparowits project. They also noted that if other participating utilities also install additional oil-fired capacity to replace Kaiparowits, annual fuel oil consumption would increase by about 33 million barrels.

SCE has existing generating station sites with sufficient space and water to support expansion, but doubted that this could occur because of regulatory standards and restrictions where these are located. Therefore, other

sites would have to be found. However, detailed studies have not been conducted to determine suitable locations for the 23 combustion turbine units or five combined cycle units that SCE believed would be required to replace their 1,200 MW share of the proposed Kaiparowits capacity.

San Diego Gas and Electric

San Diego officials reported they had few, if any, alternatives in case of denial or indefinite delay. They anticipate exploration of possibilities that replacement with oil-fired combined cycle units would be necessary, but doubt that these would be approved within the time frame that they believe would be necessary in order to meet expected demands. As does Southern California Edison, the company also believes future oil supplies may be uncertain, and there would therefore be a risk in choosing such alternatives.

Arizona Public Service Company

APS doubted that nuclear, geothermal, or other generating systems could be provided in the time frame of expected increases in demand. No specific sites or plans for additional generating capacity were identified.

If the participants' assumptions as to future demands in the market areas are correct, and that the only alternatives are oil-fired electric generation, the resulting consumption of fuel-oil may increase considerably. The Federal Energy Administration (see Appendix) indicates an oil-fired station the size of Kaiparowits would consume 80,000 barrels of oil per day or about 29 million barrels annually. There are, however, no definite indications of where potential generating stations to supply a combined total of 3,000 MW would be located.

Southern California Edison's estimate of a 5 percent per year increase in the differential between the cost of Btu's from coal and the cost of Btu's

from oil, the use of fuel oil to supply 3,000 MW would cost the utilities and eventually their customers an average of $350 million additionally per year in 1980-1993.

Assuming also that the participants' forecasts of future demands for electricity in their service areas are correct or that, even if they are inaccurate, the demand would increase, and that additional generating capacity were not available in sufficient time, there are implications of several other effects. These are discussed in Chapter III, particularly as socioeconomic impacts in the Kaiparowits Plateau impact area and in the market areas, and in the Federal Energy Administration report, Appendix I-1. In general, the most notable effects could be inability to provide employment for an increasing population in the market areas, the possibility of brown-outs or even black-outs, continued decrease in the population of Page, Arizona, and no alteration of the recent employment-unemployment patterns in Kane and Garfield counties. Increased unemployment and failure to generate new employment could be the result of lack of industrial and commercial growth because of insufficiently increasing availability of electricity and, in the Kaiparowits Plateau impact area, no employment related to the proposed project. In the market areas, the potential effects cannot be exactly determined because it is not known how people would react, whether or not some additional electricity might be available in the 1980's and how much might be generated, and whether or not energy conservation practices may be utilized (see Conservation section in this chapter).

In the Kaiparowits Plateau impact area, however, these variables would not exist. It would therefore be likely that employment trends in the area would be unchanged. Page, Arizona, may continue to decline rapidly in population to some level near 3,000 where stabilization would occur, consisting of "permanent" residents employed at the Navajo plant, by the Federal Government, and in services

supporting these people and tourists. If tourism should decline because of gasoline scarcity or expense and economic recession, Page may be further depopulated. The result is that many buildings and facilities will be unoccupied and unused, and that the municipal tax base will decline still further.

Denial of the project would, however, tend to leave the natural environment of the Kaiparowits Plateau and proposed transmission system areas essentially unchanged, as discussed at the end of Chapter II. However, water, coal, and other resources would then be available for uses other than as proposed.

If denial applied only to the proposed generating station, but coal mining were to take place, the effects would depend on the extent of mining, but would be basically the same in nature as discussed in Chapters III, V, VI, and VII, except for effects directly attributable to the generating station and transmission system. It could be assumed, for instance, that if mining were conducted to the same extent as proposed, that is 12 million tons per year gross, the physical impacts due to mining, access highway, and limestone quarrying and hauling would be the same as described. A somewhat smaller water pipe line from Lake Powell may be needed, assuming that the participants could obtain water from Lake Powell, but the environmental disturbance would be the same except for the presently proposed extension of the line to Fourmile Bench. If a new town were developed, the impacts would also be as described previously, except that the scale might be reduced because of a total population increase of perhaps 10,000, as opposed to nearly 14,000.

However, the coal would have to be exported from the mining area if no generating station existed in the Kaiparowits Plateau area. The general nature of impacts was described in this chapter, under Alternative Sites Outside Utah, if coal were to be conveyed by slurry pipe line or railroad across the Colorado River near Glen Canyon Dam or west, past Kanab, to Cedar City. It is unlikely

that coal could be transported directly eastward, because of extremely rugged canyon terrain. Transportation to the north by slurry or railroad might be feasible. A route would have to be determined, however. Effects would include environmental disturbance of forested areas, impacts on Bryce Canyon National Park if the route were parallel to the proposed limestone haulage route, and possible multiple use of the railroad to transport supplies and products. The latter might stimulate tourism and encourage other industries.

Routes that might be taken to export coal would depend on where market for the coal might be found. Availability of markets and the feasibility of transporting coal would determine whether mining would be feasible. One possible use of the coal would be in an expanded Mohave generating station in Nevada. This alternative was considered in this chapter as an alternative site outside Utah.

As presently proposed, the coal mine would use 3,100 acre-feet of water a year. Should the coal mine be the only project that goes into operation, then approximately 99,000 acre-feet of water would be available each year to be used in other projects of the Upper Colorado River Basin in Utah. The water could be used for gas liquefaction of coal, processing bituminous sands, processing oil shale and growth of food and fiber for an expanding population.

Alternative uses of water

It has been the long standing policy of the Department of the Interior to honor priorities and wishes of the states in which projects are located; therefore, the Department holds that the State of Utah should establish priorities for any alternative uses of water appropriated for the Kaiparowits power plant.

Several water right applications have been filed in the Utah State Engineer's Office for energy related projects in the Lake Powell area, as shown in Figure VIII-34. All of these applications currently have an unapproved status awaiting action by the State Engineer.

FIGURE VIII-34

Water Right Applications for Energy Related Projects
In the Lake Powell Area

Application Number	Applicant	Source of Water	Amount (Acre-feet)	Use
39721	Utah Power and Light Company	Escalante River	50,000	Steam generation, domestic
40454	Utah Power and Light Company	Escalante River	50,000	Steam generation
40592	Intermountain Consumer Power Assoc.	Escalante River	35,000	Steam generation
40670	Utah Power and Light Company	Escalante River	50,000	Steam generation, domestic
41086	Utah Power and Light Company	Escalante River	50,000	Steam generation
41138	GarKane Power	Groundwater & Fremont River	100,000	Steam generation, domestic
43124	Kaiparowits Coal and Chemical Co.	Lake Powell	100,000	Industry
		TOTAL	435,000	

Coal gasification and liquefaction as discussed earlier in this chapter and in Chapter I are also alternative uses of water. The need for an 864 million cubic feet per day coal gasification plant is projected for the Colorado River Basin in Utah; water for this plant (52,000 acre-feet) is part of the Kaiparowits Coal and Chemical Company filing on Lake Powell.

Utah is responsible for allocation of its share of water in the Upper Colorado River Basin. As a result, when Utah makes a commitment for the use of 102,000 acre-feet of water on Kaiparowits Plateau out of Lake Powell, such action forecloses the use of the same amount of water at some other point in the state. There is presently allocated 102,000 acre-feet of Utah's unused portion of the Colorado River allotment under special conditions that would commit a gradually

increasing amount of water, up to 102,000 acre-feet in 1989, after which the water would be reallocated to the Central Utah Water Conservancy District for use in the Central Utah Project. If the decision is made to allow development of the Kaiparowits proposal, the commitment forecloses alternative uses of the water for the time period detailed in the agreement, excepting other minor uses associated with the power development.

If construction of the Kaiparowits project were not approved, other uses might be made of the water allocated to it, although legal clarification would need to be obtained as to the remaining rights of the participants. The Kaiparowits project as proposed would require roughly 45,000 acre-feet of water per year, 41,400 for condenser cooling, 3,100 for coal washing. The Upper Basin Compact of 1948 allots Utah 23 percent of the Upper Basin allotment, or 1,714,000 acre-feet of the 7.5 million acre-feet on which the original allotments were based. The Department of Interior ("Report on Water for Energy in the Upper Colorado River Basin, USDI, July 1974") has assumed that about 6.5 million acre-feet is actually available, of which about 1,483,000 acre-feet would go to Utah. The 45,000 acre-feet needed by the Kaiparowits project would be about 0.6 percent of the 7.5 million acre-feet on which the compact was based, 0.7 percent of the 6.5 million acre-feet assumed available in the Colorado River, 2.6 percent of Utah's presumed allotment under the compact, and 3.4 percent of Utah's allotment assumed available by the Department of the Interior study.

Nevertheless, the use of 45,000 acre-feet of water would preclude the use of the water in other developments, some of which could rival the Kaiparowits project in economic importance (See Figure VIII-35).

The Department of Interior study referenced above concluded that the amount of water available from the Colorado River for Utah would exceed Utah's present, planned, and projected needs for all purposes beyond 1990 and probably beyond 2000. The question of water allotments, as opposed to water availability,

FIGURE VIII-35

Alternative Uses of 45,000 Acre Feet To Be Used in Condenser Cooling at the Kaiparowits Project

	Approximate Impact on Oil Supply	Approx Value of annual output ($millions)
Kaiparowits (3000 megawatts, excludes water requirements for coal mine and associated community which might require an additional 7000 acre feet.)	Displaces 80,000 bbl/day	420 at generating station @ $0.020/kW
Oil Shale Production	[a]200,000-600,000 bbl/day	73-219 @ $10 per bbl
Coal Liquefaction	[b]60,000-400,000 bbl/day (40,000-300,000 bbl/day net)	220-1,460 @ $10 per bbl
Coal Gasification	[c]100,000-400,000 bbl/day equivalent (50,000-260,000 bbl/day net)	365-460 @ $10 per bbl
[d]Irrigation of approximately 30,000 acres with typical Utah crop pattern		8.0
Coal slurry sufficient for transport of approximately 200,000 tons of coal per day	Equivalent to 700,000 bpd.	

[a] No net energy figure is given since the oil shale process, which consumes approximately 0.4 barrels of shale oil for each barrel produced, consumes energy which otherwise would not be used; therefore, the net efficiency of the process is not significant in so far as questions of alternative uses of resources are concerned.

[b] W. W. Bodle and K. C. Vyan, "Clean Fuels from Coal," The Oil and Gas Journal, August 26, 1974; p. 74.

[c] High Btu gas; ibid.

[d] From information supplied to FEA by Upper Colorado River Office, Bureau of Reclamation in letter dated August 13, 1974.

is still a large one, and the question of water availability still looms large in the future development of the state.

Alternative uses of coal

In the United States, coal is used almost exclusively as a source of heat and power. Some coal is converted to metallurgical coke before it is used for heat. In 1971, the electric utility market accounted for 66 percent of total bituminous coal and lignite consumption. About 18 percent of coal consumption in 1971 was by primary metal industries. Only 11.4 million tons of coal were used for home and commercial heating in 1971. The remainder was used in other industries (U.S. Dept. of Interior, BLM: Programmatic Environmental Statement, Proposed Federal Coal Leasing in the United States of America, 1975).

The Kaiparowits project would consume coal which might be used for purposes other than generation of electric power. But, because coal reserves are abundant, the use of coal for electric power generation does not, at present, compete with the use of coal for other purposes such as gasification or liquefaction. In other words, the use of 9 million tons per year for generating electricity will not eliminate the opportunity for developing other uses of coal in the area.

Major future users of coal are expected to be those same industries now consuming it. In addition, coal will be used to manufacture synthetic gas and liquid fuels on a scale which should equal or exceed the use for electric power generation by the year 2000. The Bureau of Mines has projected that by 1985 each of 36 coal-gasification plants will be manufacturing more than 250 million cubic feet of pipeline gas per day, and each will be consuming 6 to 10 million tons of coal per year. It has been projected that requirements in the year 2000 for liquefaction and gasification combined will be as high as 1,274 million tons (USDI, BLM, EIS, Coal Leasing, 1975).

The 9 million tons of coal that would be consumed by the Kaiparowits power plant each year could be utilized in a coal gasification plant to produce 245 million cubic feet per day of gas. However, such a gasification system would require a water consumptive rate of 4,676 gallons a minute or 7,550 acre-feet a year. Also, the heating value of the gas produced would be only 65 to 75 percent of the heating value of the coal consumed (Bureau of Reclamation, 1974).

Environmental impacts resulting from the use of coal for gasification is discussed under Alternative Means of Meeting Project Objectives.

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